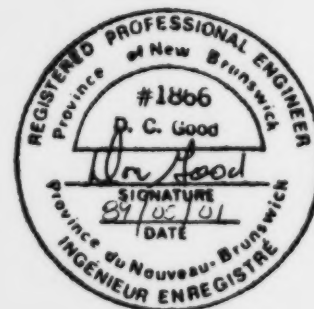


**A HIGHWAY IMPROVEMENT PLAN
FOR THE TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK**

Prepared For:

The New Brunswick Department of Transportation
and
Transport Canada



May, 1989

FGA **FIANDER - GOOD**
ASSOCIATES LTD.

May 1, 1989

88-0527-11

Mr. Brian McEwing, P. Eng.
Assistant Director of Planning
Department of Transportation
P.O. Box 6000
Fredericton, NB
E3B 5H1

RE: HIGHWAY IMPROVEMENT PLAN FOR THE TRANS CANADA
HIGHWAY THROUGH NEW BRUNSWICK - FINAL REPORT

Dear Mr. McEwing:

I have enclosed our final report relating to the above project. We have found this study both challenging and interesting and appreciate the opportunity to have worked with you and your Steering Committee.

Yours truly,



DON GOOD, P. ENG.
VICE-PRESIDENT

DCG/rc

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STUDY HIGHLIGHTS

The overall objective of this study has been to assess current and forecast deficiencies of the Trans Canada Highway in New Brunswick and its connecting links to the City of Saint John over the next 15 to 20 years; and to develop highway improvement implementation plans for the study network that will adequately address the deficiencies of all highway segments in the order of their relative urgency.

The study network includes over 780 km of arterial highways; and is comprised of four primary highway routes:

- 1). the Trans Canada Highway (Route 2) between the Quebec and Nova Scotia borders;
- 2). the Trans Canada Highway (Route 16) between Aulac and Cape Tormentine;
- 3). Route 1 between Saint John and Sussex; and
- 4). Route 7 between Fredericton and Saint John.

These highway routes have been divided into 39 segments for analysis and evaluation.

Following are the summary highlights of the major findings of this study.

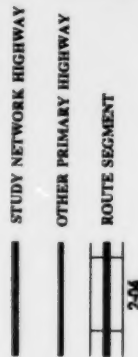
- o The study highway network routes are mostly two lane facilities with their limited capacity strategically supplemented by climbing and left turning lanes.
- o The study highway network routes essentially function as:
 - local roads for commuters and local service traffic;
 - primary intra-provincial arterial routes connecting the regions within the Province;
 - primary arterial routes collecting and distributing inter-provincial traffic to and from the Province; and
 - corridors to out-of-province traffic passing through the Province.
- o Traffic levels on the study highway network have increased considerably since the system was designed. Historic traffic levels of the network have grown at average annual rates of close to 4 percent traffic. Traffic growth on highway segments in urban areas has exceeded 5 percent per annum. Present traffic levels on the study highway segments range from a low of 2,140 to a high of 16,895 average annual daily vehicles, and commonly average between 5,000 to 8,000 vehicles per day. Design hourly volumes, a measure of average peak traffic, typically range between 700 and 1,200 vehicles per hour.
- o Percentage passing sight distances throughout the study highway network are fairly low due to the prevalent steep grades and winding horizontal curvature of the highways.

These factors further limit the capacity of the two-lane facilities. As a result, traffic flows commonly congregate in a platoon fashion, which perpetuates risky passing manoeuvres by impatient and anxious drivers.

- o Average truck traffic on the study highway network is approaching 20 percent of the total traffic, or in other words, one of every five vehicles on the highways is a truck.
- o Thirty-two of the thirty-nine highway segments, or almost 81 percent of the entire study network, are presently operating below level of service C, which is the design standard selected for this study. For example, more than 94 percent of the Trans Canada Highway Route 2 is operating below level of service C. In fact, 46 percent of the study network is at or approaching capacity (ie. level of service E) and in one case is exceeding capacity (ie. level of service F).
- o Recent annual average accident rates of the highway segments range from 0.22 to 1.79 accidents per million vehicle kilometres. Approximately 1,050 accidents per year have occurred on the study network, 73 percent of these on the Trans Canada Highway Route 2. Approximately 28 percent of the accidents have involved fatalities or personal injuries to vehicle occupants. An average of 24 fatalities per year occurs on the study network.
- o There are approximately 5,000 private driveways with direct highway access to the Trans Canada Highway. Roadside developments present a major safety hazard on high volume traffic two lane routes throughout the study network. Frequent traffic flow interruptions and hazardous manoeuvres result. This is compounded by prevalent at-grade intersections with other public highways and residential streets.
- o Automobile traffic is projected to grow at 2.7 percent per annum on the rural area highways and 5.0 percent in the urban areas. Truck traffic is projected to grow at 2.2 percent per annum. This is equivalent to a 70 percent increase in auto traffic in rural areas and a 165 percent increase (more than double) in urban areas over the 20 year forecast period. Truck traffic is projected to increase by 55 percent in the next 20 years.
- o Based on the projected traffic growth rates, almost 99 percent of the study highway network could be operating below level of service C by year 2008. At that rate, approximately 63 percent of the highway segments could be operating at level of service E, at or near their capacities, while 30 percent of the highways could be at over-capacity service level F. Figure 1 illustrates the "do nothing" scenario of predicted highway segment service levels by year 2008, should the highway deficiencies not be addressed.
- o Although no detailed analysis was completed on stop gap measures, including the provision of additional climbing and left turning lanes, or other options such as the

LEGEND:

LEVEL OF SERVICE



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FIGURE 1
PROJECTED LEVELS OF SERVICE
IN 2008 WITHOUT PROPOSED
HIGHWAY IMPROVEMENTS

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

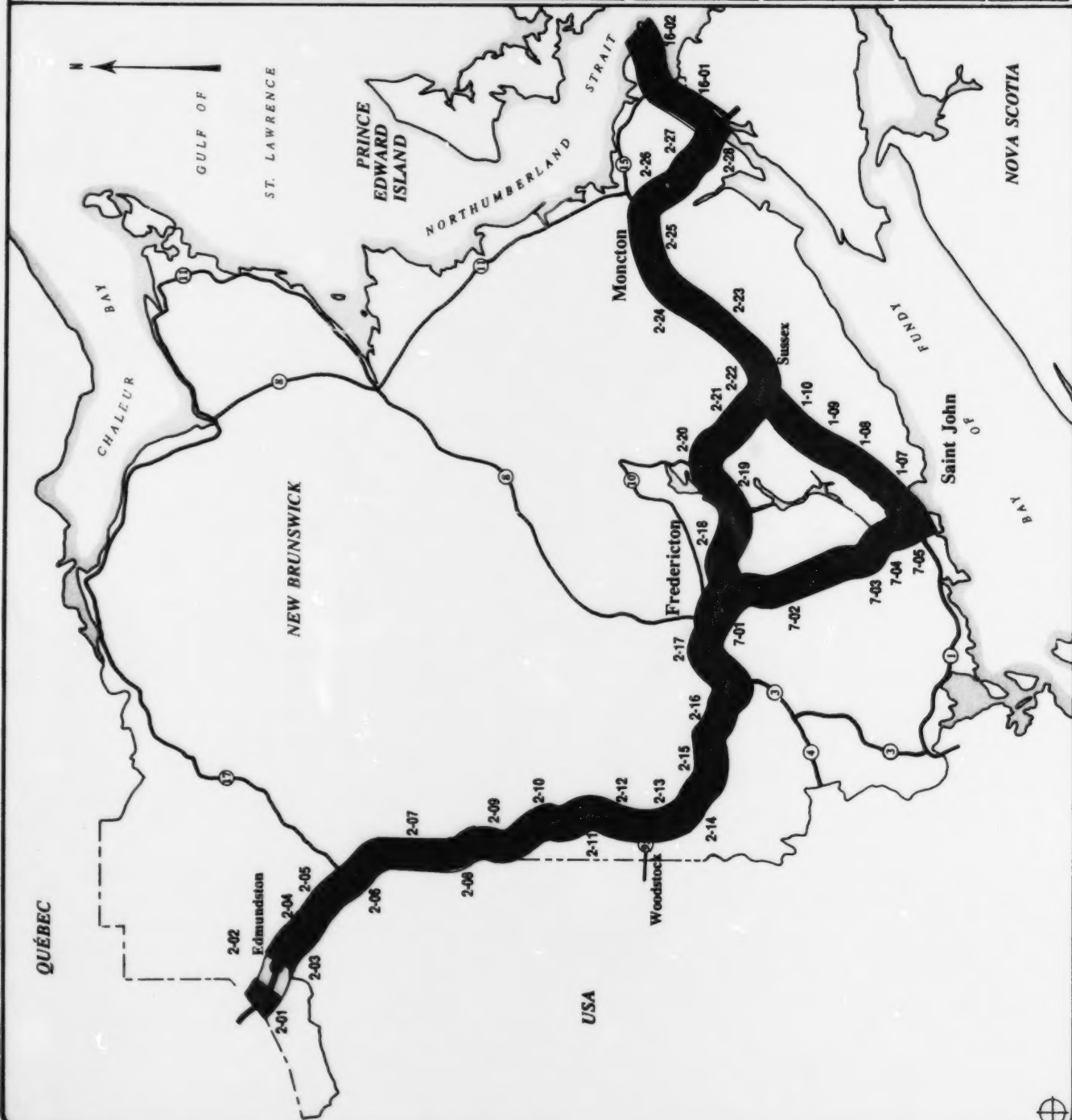
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addition of passing lanes, lane and shoulder widening, or horizontal and vertical alignment improvements, it was felt that such improvements would not be sufficient to address the degree of current and projected level of service deficiencies.

- o It is recommended that to adequately facilitate existing and projected traffic demand the study network should be upgraded to a four lane divided fully access controlled highway. This level of upgrading would eliminate all forecast network level of service deficiencies with the exception of highway segment 1-07 from Saint John to Gondola Point. This section is presently a four-lane divided facility and could require upgrading to six lanes or more by year 2008. Figure 2 illustrates the predicted service levels of the highway segments with all upgrading improvements implemented by year 2008.
- o The forecast level of service deficiencies were found to be relatively insensitive to high and low traffic growth scenarios as compared to the base case projections.
- o The estimated cost of upgrading the study network to four lane divided status is \$1,979 million in 1988 dollars. Almost three-quarters of these costs would be allocated to the Trans Canada Highway Route 2.
- o The gross economic impact, or "spin-offs", of the highway improvement expenditures of \$1,979 million would generate an additional \$1,468 million of indirect expenditures on labour and materials within the Province. A total of 13,556 person-years of construction employment and an additional 12,468 person-years of indirect other related employment activities would be generated by the construction projects. In total over 26,000 person-years of employment would be generated by the study network highway improvement expenditures. Gross economic impacts do not account for the displacement of economic activity in other sectors of the economy resulting from financing the proposed highway improvements.
- o The highway improvements would result in substantial time savings to users of the highways. For example, an average trip from the Nova Scotia to Quebec borders on the Trans Canada Highway could be reduced from one half to one and a half hours depending upon the prevailing traffic conditions.
- o It is predicted that an average annual reduction between 346 and 692 accidents throughout the study network could result from upgrading the highways to four lane divided fully access controlled status. An estimated average of eight to sixteen fatalities could be avoided per year on the study network.
- o Present Provincial program funding levels for highway construction projects on the study network would permit completion of approximately 12 percent of the proposed

LEGEND:

LEVEL OF SERVICE



A to C



D

STUDY NETWORK HIGHWAY

OTHER PRIMARY HIGHWAY

ROUTE SEGMENT

2-04

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FIGURE 2
PROJECTED LEVELS OF SERVICE
IN 2008 WITH ALL PROPOSED
HIGHWAY IMPROVEMENTS
COMPLETED

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN:
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

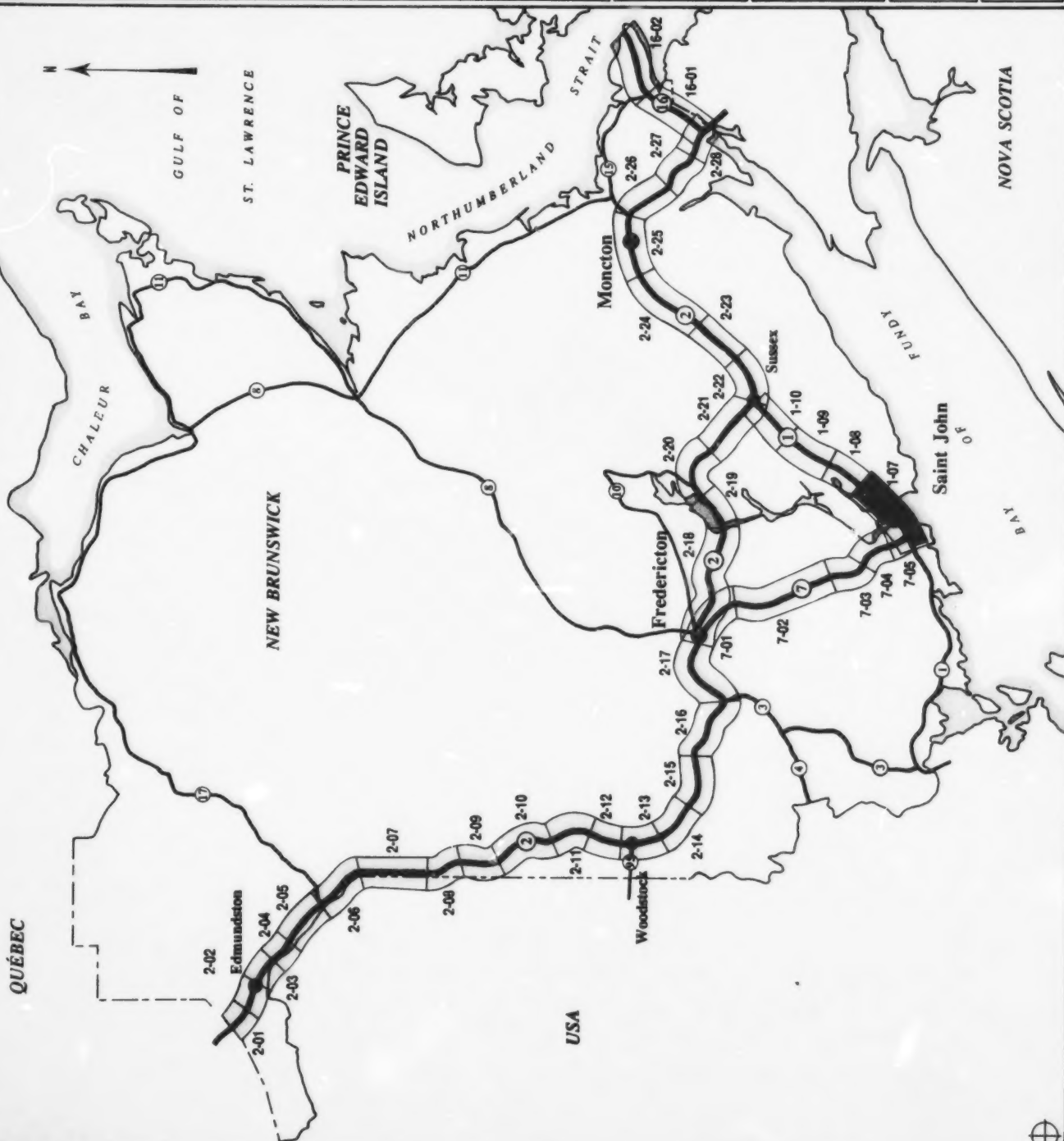
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improvements to year 2008. By including existing Federal/Provincial spending levels on the study highway network 21 percent of the highway improvements could be completed. Considerable supplementary funding is required to upgrade the study highway network to meet present and future traffic demands and improve safety. On January 1, 1989, the Province of New Brunswick raised fuel taxes by 1.9 cents per litre on gasoline and 3.1 cents per litre on diesel fuel and earmarked the revenue from this fuel tax increase to a Highway Trust Fund.

- o Highway improvement implementation plans have been developed from an evaluation of the relative urgency of upgrading the highway segments based on service, safety and economic factors. The resulting project priority list was then subjected to four postulated funding level scenarios.

Scenario 1: This assumes the Province will maintain its present level of annual expenditures on the study network, plus an annual allocation of \$8 million from the Highway Trust Fund, for a total average of \$19.8 million per annum in 1988 dollars until year 2008. This level of funding would permit 20 percent of the proposed highway improvements to be completed.

Scenario 2: This assumes that both the levels of Provincial and Federal/Provincial program spending will be maintained, plus an annual allocation of \$8 million from the Highway Trust Fund, for a total average of \$28.8 million per annum in 1988 dollars until year 2008. This level of funding would permit 29 percent of the proposed highway improvements to be completed.

Scenario 3: This assumes that sufficient funding is available to implement all proposed highway improvements to the study network required to eliminate all forecast level of service deficiencies in a 20 year period to 2008 at an average annual cost of \$99.0 million in 1988 dollars.

Scenario 4: This assumes that sufficient funding is available to implement all proposed highway improvements to the study network required to eliminate all forecast level of service deficiencies in a 15 year period to 2003 at an average annual cost of \$131.9 million in 1988 dollars.

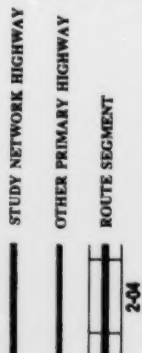
- o Four highway improvement implementation plans have been developed from the evaluation of the relative urgency of the route segments, subject to the four funding level scenarios. Figures 3 to 6 illustrate the implementation priority phasing of the highway improvements in five year periods. Figures 3 and 4 demonstrate the inability of the traditional levels of funding supplemented by the Highway Trust Fund, described in Scenarios 1 and 2, respectively, to accommodate the proposed study network

LEGEND:

IMPLEMENTATION PHASES



NOTE: AVERAGE = \$19.8 M. per annum (\$ 1988)



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FIGURE 3

SCENARIO #1
PROVINCIAL FUNDING LEVEL
PLUS HIGHWAY TRUST FUND
ALLOCATION

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

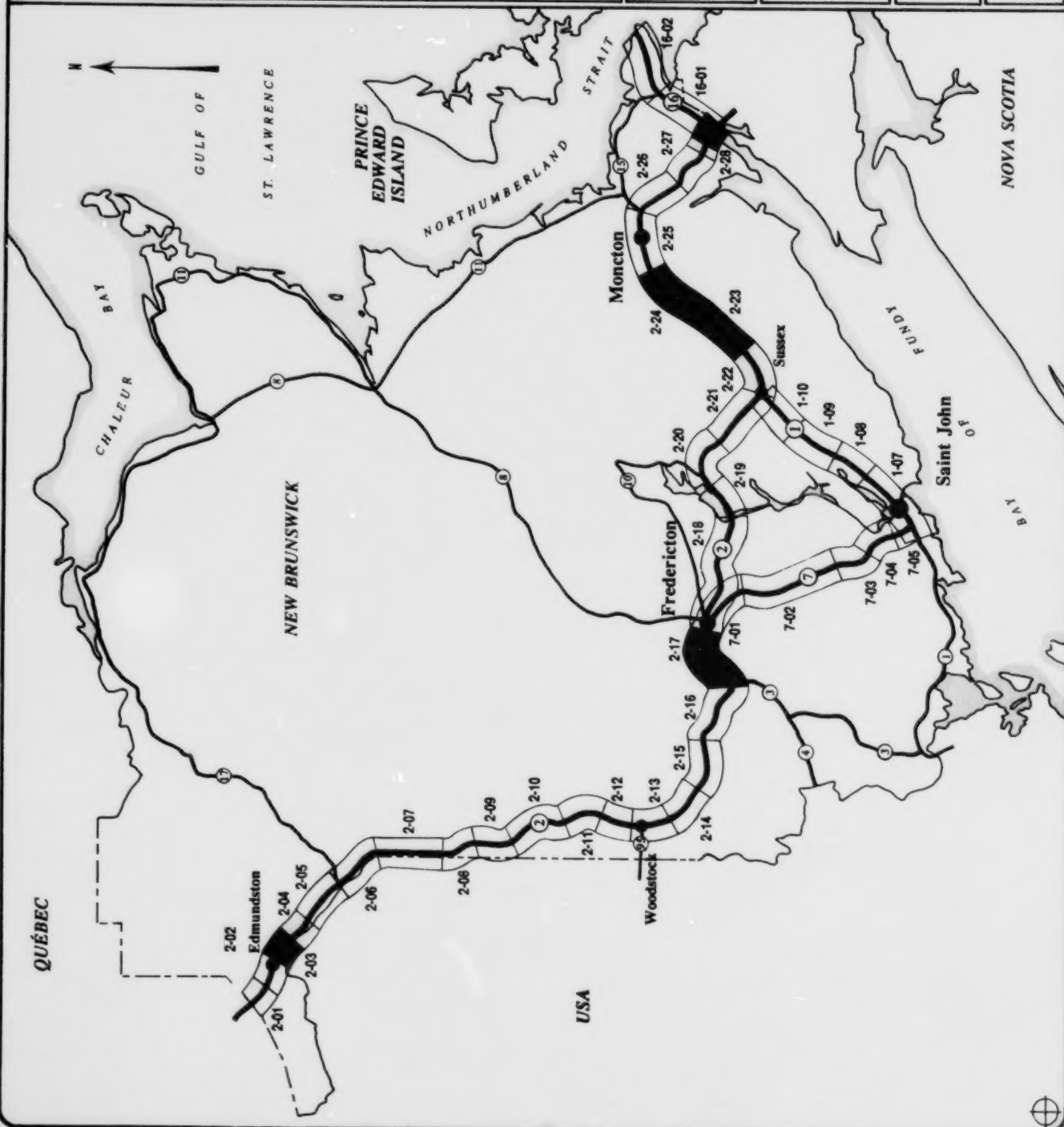
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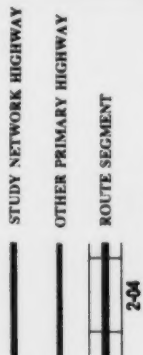


LEGEND:

IMPLEMENTATION PHASES



NOTE: AVERAGE = \$28.8 M. per annum (\$ 1988)



DRAWING TITLE: **FIGURE 4**

**SCENARIO #2
PROVINCIAL AND FEDERAL /
PROVINCIAL FUNDING LEVELS
PLUS HIGHWAY TRUST FUND
ALLOCATION**

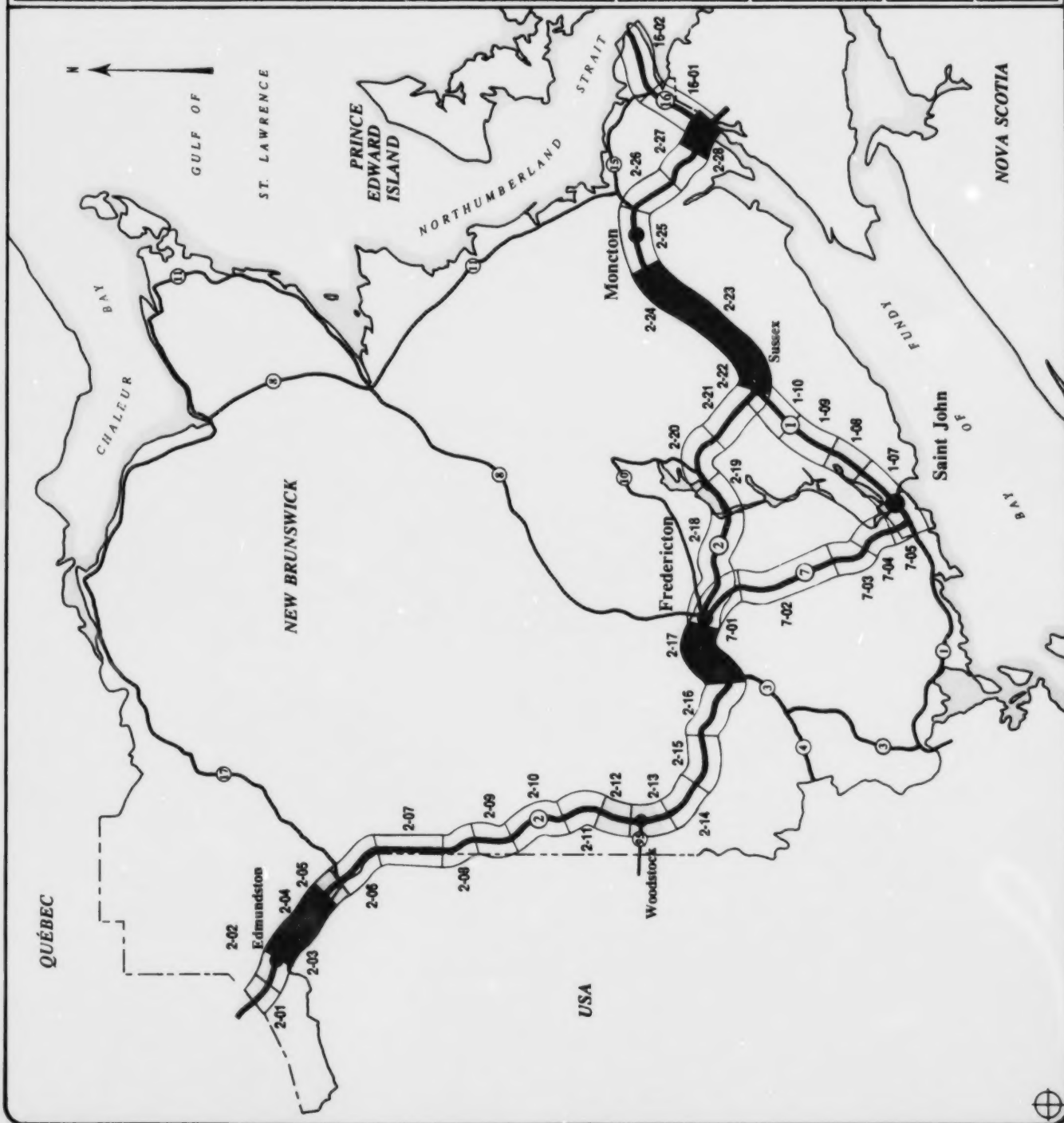
PROJECT TITLE:

**A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK**

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PROJECT #: 517-11

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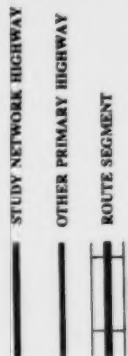
improvements. Figures 5 and 6 illustrate the priority sequencing of the highway segments improvements based on their relative urgency and limited only by their respective implementation periods of 20 years and 15 years.

LEGEND:

IMPLEMENTATION PHASES



NOTE: AVERAGE = \$98.96 M. per annum (\$ 1988)



2-04

DRAWING TITLE: **FIGURE 5**

SCENARIO #3
FUNDING LEVEL TO
COMPLETE PROPOSED NETWORK
IMPROVEMENTS IN 20 YEARS

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

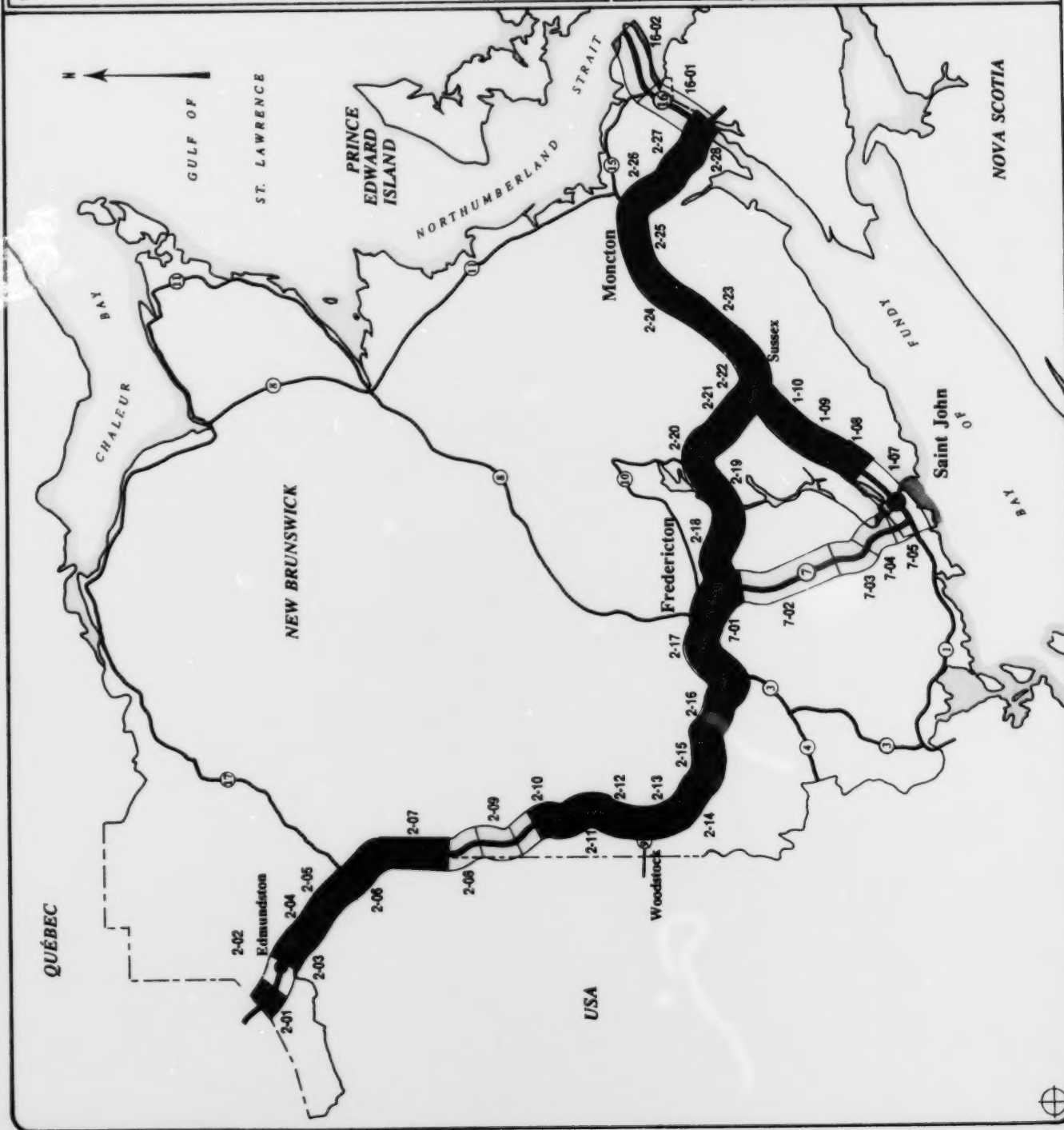
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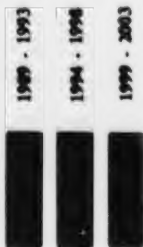
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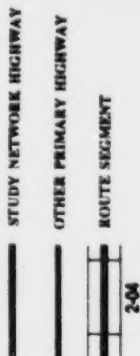


LEGEND:

IMPLEMENTATION PHASES



NOTE: AVERAGE = \$131.9 M. per annum
(\$ 1988)



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FIGURE 6

SCENARIO #4
FUNDING LEVEL TO
COMPLETE PROPOSED NETWORK
IMPROVEMENTS IN 15 YEARS

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

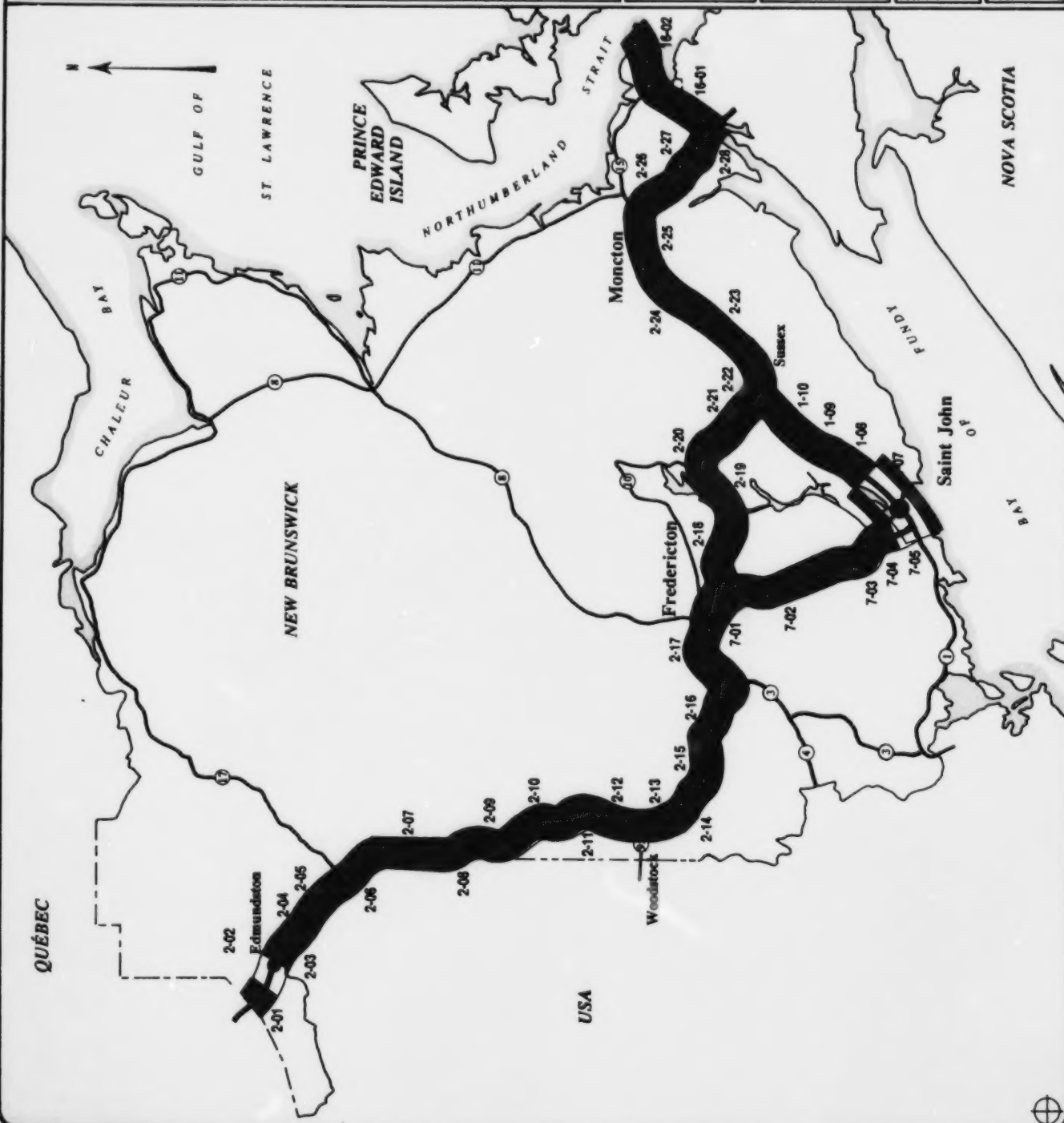
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1.0 INTRODUCTION

1.1 Background

New Brunswick's primary highways are almost entirely two-lane routes which have been called upon to accommodate local automobile and truck traffic, as well as intra-provincial, inter-provincial and out-of-province traffic passing through the province. Traffic levels have increased dramatically since the design and construction of the Trans Canada Highway in the fifties. This has been compounded by the substantial increase in the proportion of truck traffic, which has resulted from the improved competitive position of the trucking industry vis-a-vis other modes, as well as the recent and on-going abandonment of branch rail lines in the Atlantic Region. Meanwhile, considerable growth in the number of private roadside developments with direct access to the primary highways has taken place.

All of these factors have contributed to a gradual deterioration in the level of service and safety of the Trans Canada Highway and other major arterial links to communities throughout New Brunswick. The Province of New Brunswick is especially concerned with the current status and deficiencies of the Trans Canada Highway and its connecting links to Saint John and the network's ability to accommodate traffic into the future.

Both the Provincial and Federal governments recognize that a good highway system is essential to the economic development and well being of New Brunswick. In October 1986, both governments signed a document outlining the agreed Cause of Action under the Canada/New Brunswick Economic and Regional Development Agreement (ERDA). The agreement recognizes the need for the federal and provincial Ministers of Transportation to examine joint priorities for new transportation investments as they pertain to developing a long term transportation agreement.

This statement of intent was reinforced by the program strategy of the Canada-New Brunswick Highway Improvement Program 1987/88 to 1991/92. Part of Schedule A of this agreement stated:

"Inter Provincial Highways"

The program will develop a new focus towards upgrading such highly travelled corridors of the Trans Canada Highway, Route 1 and Route 7 which play such a significant role in the inter-provincial movement of goods and people. The focus of the program will be towards improving current and anticipated future deficiencies in traffic carrying capacity and highway safety.

New Brunswick's highway system is comprised of over 20,000 km, the majority of which is under the jurisdiction of the Department of Transportation. The arterial highway system totals 2,000 km or approximately 10 percent of all highways; however, these highways handle up to 70 percent of

the total vehicle-kilometres driven on rural highways. Therefore, it is essential that New Brunswick's primary highway system be maintained and upgraded in a manner which will efficiently and safely accommodate existing and future traffic demand.

A Technical Steering Committee comprised of representatives of the New Brunswick Department of Transportation and Transport Canada was struck to provide direction and background information, as well as ensure that the objectives of the study were met to the satisfaction of both government departments. The Consultant worked closely with the Technical Steering Committee throughout the study.

1.2 Study Objectives

The overall objective of this study has been to assess the magnitude of current and forecast deficiencies on the Trans Canada Highway in New Brunswick and its connecting links to the City of Saint John over the next 15 to 20 years, and to develop study highway network improvement implementation plans that will adequately address these deficiencies. The study highway network includes the following routes:

- o the Trans Canada Highway (Route 2) between the Quebec and Nova Scotia borders;
- o Trans Canada Highway (Route 16) between Aulac and Cape Tormentine;
- o Route 1 between Saint John and Sussex; and
- o Route 7 between Fredericton and Saint John.

The study addresses three underlying objectives:

- 1). Review and highlight the strategic role that the Trans Canada Highway and its links to Saint John play with respect to the general commerce and overall economic development on a provincial, regional and national scale.
- 2). Review, document and supplement, if necessary, the existing data base on current and forecast needs or deficiencies on a highway segment basis with respect to level of service, safety and structural adequacy and generate, in consultation with the Province, acceptable improvement alternatives and the cost of such improvements.
- 3). Rank the improvement alternatives in terms of relative priority or urgency and develop an overall highway system plan based on a number of financial and traffic/mix growth scenarios.

1.3 Study Scope

The evaluation and results documented in this report are based on 781.1 km of highway, which have been subdivided into 39 highway route segments. These highway segments were ascribed by the Department of Transportation for each of the four routes and are presented in Table 1.1. Figure 1.1 illustrates the study highway network and highway segments in relation to the provincial primary highway system.

The study highway network is comprised of 735.8 km (94.2 percent) of 2 lane highway and 45.3 km (5.8 percent) of 4 lane highway.

The Terms of Reference to this project specified that 7 major tasks were to be completed. These tasks are summarized as follow:

- 1). A review and documentation of the study highway network current status on a route segment basis, expressed in terms of average annual daily traffic, average annual daily truck traffic, seasonal variations and the degree of roadside development.
- 2). An identification of the importance of the routes and route segments comprising the study network and the role that each plays with respect to the general commerce and overall economic development on a provincial, regional and national scale.
- 3). A review and documentation on the current and future forecast (1998 and 2008) status of the study network on a route segment basis with respect to evaluation parameters such as level of service and safety. This evaluation provides an overview of the magnitude of current and forecast deficiencies of the study network.
- 4). A review and documentation of improvement alternatives for the deficiencies identified in Task #3 above and the costs associated with these improvements.
- 5). The development of a highway improvement priority ranking scheme.
- 6). A review of current and historical budget levels for the Province and the Department of Transportation.
- 7). The development of an overall highway system plan for implementation of the proposed improvements identified in Task #4. Four separate implementation strategies in 5 year increments were developed based on the following funding scenarios:

Table 1.1

DESCRIPTION OF THE STUDY AREA HIGHWAY
NETWORK AND ASSOCIATED ROUTE SEGMENTS

Route Number	Highway Segment Number	Highway Segment Description	Distance (km)
1	1-07	Lorneville Interchange to Gondola Point Interchange	31.3
1	1-08	Gondola Point Interchange to Hampton (Woodpecker Hall Road)	14.2
1	1-09	Hampton (Woodpecker Hall Road) to Norton (Route 124)	17.6
1	1-10	Norton (Route 124) to Sussex (Route 2)	<u>17.2</u>
		ROUTE 1 DISTANCE	80.3
2	2-01	Quebec Border to St. Jacques (Riv. a la Truite Road)	10.1
2	2-02	St. Jacques (Riv. a la Truite Road) to Hebert Blvd. (Route 120)	9.2
2	2-03	Hebert Blvd. (Route 120) to Riviere-Verte (Davis Road)	14.0
2	2-04	Riviere-Verte (Davis Road) to Ste. Anne (Quisibis River)	11.0
2	2-05	Ste. Anne (Quisibis River) to St. Leonard (Route 17)	14.1
2	2-06	St. Leonard (Route 17) to Grand Falls (Saint John River)	17.9
2	2-07	Grand Falls (Saint John River) to Aroostook River	27.4
2	2-08	Aroostook River to Perth-Andover East Entrance	11.6
2	2-09	Perth-Andover East Entrance to Riviere de Chute (Route 560)	14.7
2	2-10	Riviere de Chute (Route 560) to Florenceville (Saint John River)	22.9
2	2-11	Florenceville (Saint John River) to Hartland (Saint John River)	17.9
2	2-12	Hartland (Saint John River) to Jacksonville (Route 560)	14.6
2	2-13	Jacksonville (Route 560) to Route 103 (Bull's Creek)	14.0
2	2-14	Route 103 (Bull's Creek) to Meductic (Route 122)	13.8
2	2-15	Meductic (Route 122) to Pokiok (P74)	18.9
2	2-16	Pokiok (P74) to Route 3 (Longs Creek)	31.3
2	2-17	Route 3 (Longs Creek) to Fredericton (Harwell Road)	26.1

Table 1.1
(Cont'd)DESCRIPTION OF THE STUDY AREA HIGHWAY
NETWORK AND ASSOCIATED ROUTE SEGMENTS

Route Number	Highway Segment Number	Highway Segment Description	Distance (km)
2	2-18	Fredericton (Harwell Road) to Jemseg (Route 695)	52.8
2	2-19	Jemseg (Route 695) to Mill Cove (Fowler Road)	14.7
2	2-20	Mill Cove (Fowler Road) to Coles Island (Route 112)	23.2
2	2-21	Coles Island (Route 112) to Sussex (Route 1)	32.4
2	2-22	Sussex (Route 1) to Five Points (Portage Vale Road)	22.5
2	2-23	Five Points (Portage Vale Road) to Petitcodiac (Route 905)	16.3
2	2-24	Petitcodiac (Route 905) to Moncton (Route 126)	36.1
2	2-25	Moncton (Route 126) to Scoudouc (Route 132)	23.1
2	2-26	Scoudouc (Route 132) to Memramcook East Road	15.4
2	2-27	Memramcook East Road to Sackville (Route 106)	17.7
2	2-28	Sackville (Route 106) to Nova Scotia Border	<u>8.4</u>
		ROUTE 2 DISTANCE	552.1
7	7-01	Fredericton (Route 2) to Oromocto (Geary Interchange)	16.9
7	7-02	Oromocto (Geary Interchange) to Mount Douglas Road	46.0
7	7-03	Mount Douglas Road to Westfield By-Pass	9.1
7	7-04	Westfield By-Pass to Grand Bay By-Pass	16.3
7	7-05	Grand Bay By-Pass to Saint John (Route 1)	<u>8.5</u>
		ROUTE 7 DISTANCE	96.8
16	16-01	Aulac (Route 2) to Port Elgin (Route 15)	25.9
16	16-02	Port Elgin (Route 15) to Cape Tormentine	<u>26.0</u>
		ROUTE 16 DISTANCE	51.9
		TOTAL STUDY HIGHWAY NETWORK DISTANCE	781.1

LEGEND:

- STUDY NETWORK HIGHWAY
- OTHER PRIMARY HIGHWAY
- ROUTE SEGMENT

2-04

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FIGURE 1.1
STUDY AREA
HIGHWAY NETWORK

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

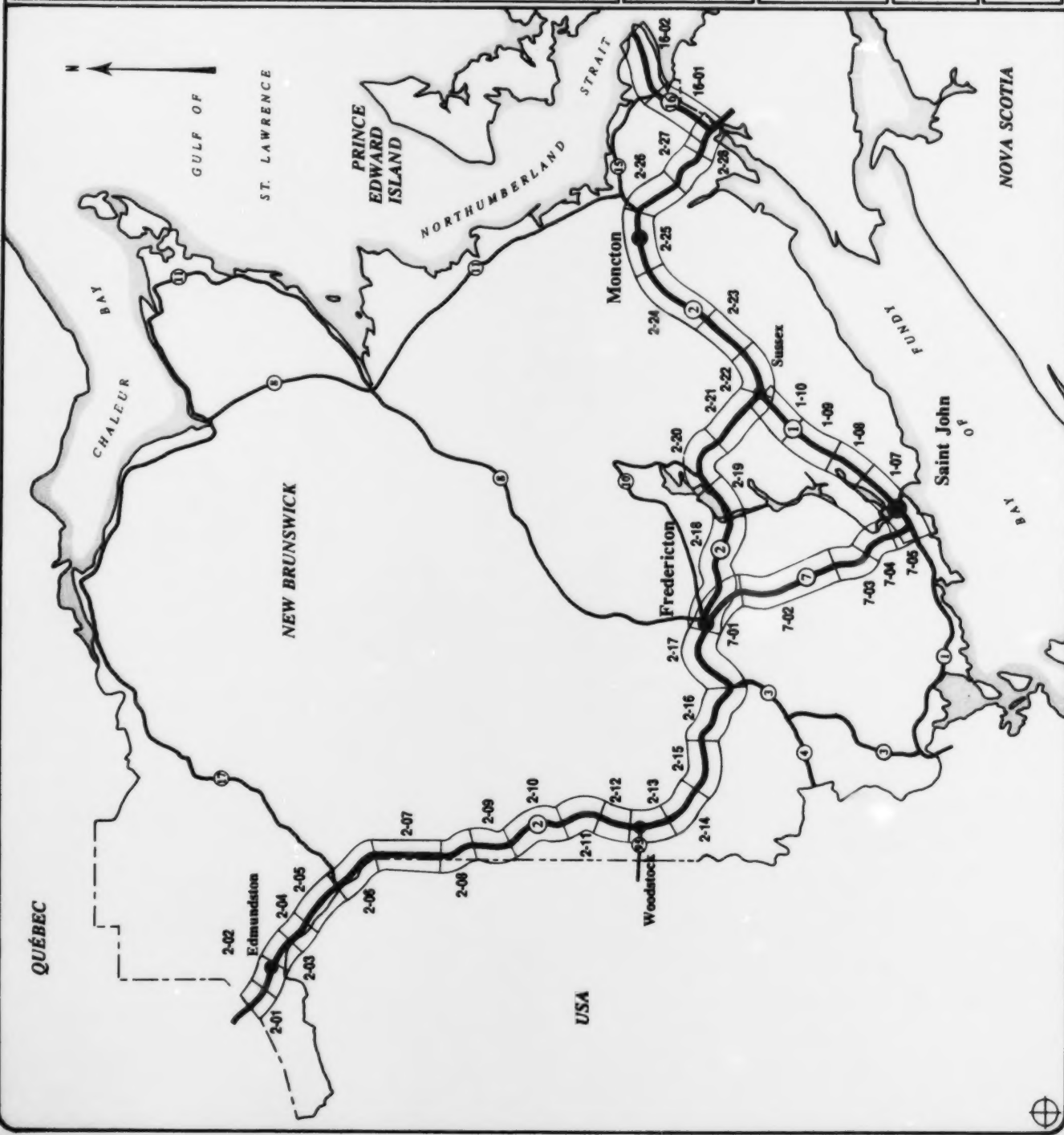
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DATE: 8/89

SCALE: Not to Scale

PROJECT #: 37-11

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- a). the Province will maintain its current level of expenditures on the study network plus an annual allocation of \$8 million from the Highway Trust Fund over the next 20 years;
- b). the existing provincial and federal/provincial funding levels for the study network will be continued plus an annual allocation of \$8 million from the Highway Trust Fund over the next 20 years;
- c). sufficient funding will be available to correct all deficiencies over the next 20 years; and
- d). sufficient funding will be available to correct all deficiencies over the next 15 years.

The major tasks described above provide an overview of the study context and framework as specified by the Terms of Reference for this project. It should be clearly noted that this study is not intended as a functional design for route alignment, nor does it address detailed benefits and costs associated with the improvement alternatives.

Data inputs to this project have been extracted from a number of previously developed documents, as well as Department of Transportation data sources. The Department maintains a large inventory of data relating to the provincial highway system, which is updated periodically. These data include the location and description of route segments, current and historical traffic volumes, accident data, sufficiency ratings, pavement characteristics, geometric characteristics, road life diagrams, classifications counts and traffic stream characteristics.

1.4 Report Content

This report provides a summary of the evaluation process and documents the findings which have been derived from completion of the various work activities. This document is intended to provide an overview and not a detailed description of all work tasks. A comprehensive Technical Background Document has been prepared which provides the detailed technical data utilized to complete this study.

This report has been structured to provide the reader with a clear and concise overview of the study highway network, its current and projected future deficiencies, the proposed improvements and funding necessary to implement the improvements, as well as priority implementation plans. Chapter 2.0 provides a description of the current study highway network status, including physical characteristics, level of service and safety. Chapter 3.0 presents the proposed improvements to the study network, including a sensitivity analysis of future traffic levels and Class D cost estimates of the highway improvements.

Chapter 4.0 identifies the economic importance of the study highway including economic and travel demand profiles, and the economic impact of highway improvement construction projects, as well as a review of the role of transportation in past, present and future economic development prospects of the Province and the Atlantic Region.

The evaluation of the relative urgency for improvements of each route segment based on service, safety and economic criteria is described in Chapter 5.0. The final chapter summarizes the highway improvement implementation strategies associated with the four funding level scenarios.

2.0 STUDY HIGHWAY NETWORK CURRENT STATUS

2.1 Introduction

This chapter provides a general description of the current status of the study highway network with respect to physical characteristics, level of service and highway safety. The accompanying figures illustrate the network status on a route segment basis. The Technical Background Document provides much more extensive details of the geometric characteristics, traffic volumes, roadside development, pavement characteristics, accident rate, sufficiency ratings and existing level of service at the rating section level. Prior to summarizing the current study highway network status, a description of level of service is appropriate at this time.

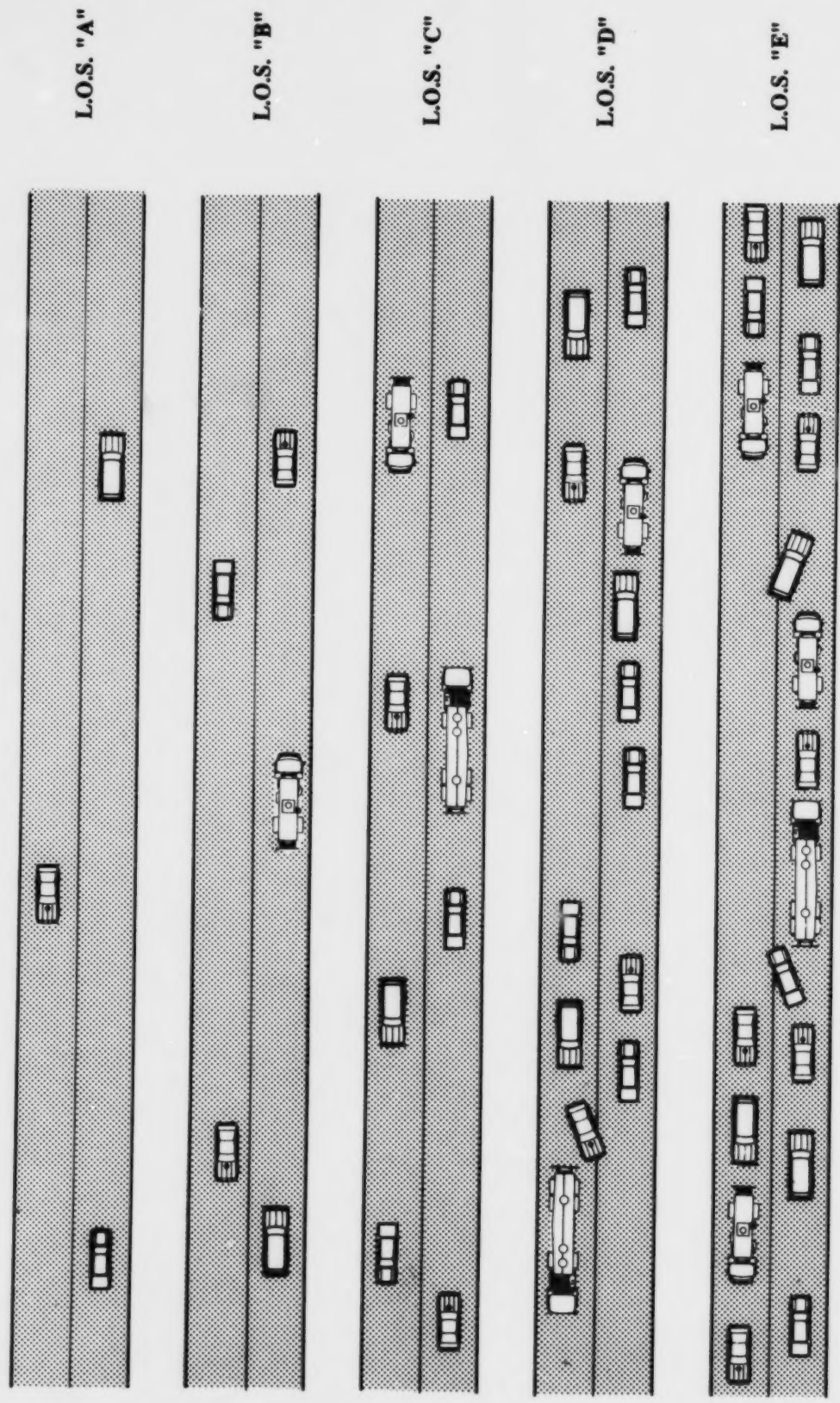
The concept of level of service is defined as a qualitative measure, describing operational conditions within a traffic stream, and their perception by motorists. These operational conditions are generally described in terms of such factors as speed and travel time, freedom of manoeuvre, traffic interruptions, comfort and convenience and safety. Capacity is defined as the maximum hourly rate at which vehicles can reasonably be expected to traverse a point or uniform section of roadway under prevailing roadway, traffic and control conditions.

Six levels of service are defined and are given letter designations from A to F, with level of service A representing the best operating conditions and level of service F the worst. To familiarize the reader further with the level of service concept, a brief definition of each of the six categories is given below. Figure 2.1 illustrates the first five levels of service as they pertain to two lane highways and provides a general indication of the congestion associated with each.

Level of service A represents free flow where individual users are unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the stable traffic stream is extremely high. In addition the general level of comfort and convenience to the motorists and passengers is excellent. Level of service B is in the range of stable flow, but the presence of other users in the traffic stream becomes apparent. Although freedom to select desired speeds is relatively unaffected, there is some decline in the freedom to manoeuvre.

Level of service C is in the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes affected by interactions with others in the traffic stream. The selection of speed is affected, the traffic flow and the general level of comfort and convenience declines noticeably. Level of service D represents high density but stable flow. Speed and freedom to manoeuvre are significantly restricted. Small increases in traffic will cause operational problems at this service level.

FIGURE 2.1
ILLUSTRATION OF TRAFFIC DENSITY PER LEVEL OF SERVICE



NOTE: THIS ILLUSTRATION IS NOT DRAWN TO SCALE.

Traffic operating conditions at or near capacity are defined by level of service E. All speeds are reduced to low, but relatively uniform values. Freedom to manoeuvre within the traffic stream is extremely difficult. Comfort and convenience levels are extremely poor, and driver frustration is generally high. Operations at this level are usually unstable, because small increases in flow will cause breakdowns. The final category, level of service F, is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Operations within the queue are characterized by stop and go waves and are extremely unstable.

Levels of service are calculated on the basis of the thirtieth highest hour of traffic and are used to measure the effectiveness of a highway to accommodate existing and/or future traffic demand. For the purpose of this study, any highway segment operating below the level of service C lower boundary has been identified for improvements. The "critical" point, therefore, is the point at which level of service C becomes level of service D.

2.2 Physical Characteristics

The portion of Route 1 included in the study network is 80.3 km in length and is comprised of four highway segments. This route functions as the primary access route between Saint John and Moncton. Thirty-nine percent of this distance is presently a four lane divided facility while the remaining distance is a two lane highway with uncontrolled access.

Route 1 is located in rolling terrain and has lane widths which range between 3.75 and 4.3 metres, while shoulder widths range from 1.62 to 3.0 metres. The percent no passing zones are between 0 percent (on the four lane divided facility) to 82 percent. The structural strength of Route 1 is generally acceptable.

Route 2, which extends between the Quebec and Nova Scotia borders is over 552 km in length and is primarily two lanes, with only 2 percent of it presently a four lane divided facility. For evaluation purposes, Route 2 was divided into 28 highway segments.

Route 2 is generally located in rolling terrain, although there are some level sections. Lane widths range between 3.65 and 5.3 metres, with shoulder widths between 1.04 and 3.11 metres. The percent no passing zones range from 0 on the four lane portions to 100 on some rating sections of the two lane facility. The structural base of the highway is generally adequate.

Route 7 extends from Fredericton to Saint John and is 96.8 km in length. It is comprised of 94.1 km of two lanes (97 percent) and 2.7 km of four lanes. This portion of the study network has been sub-divided into 5 highway segments for evaluation.

The majority of Route 7 is in rolling terrain. Lane widths range between 3.55 and 4.55 metres, with shoulder widths of 2 to 3 metres. Percent no passing zones vary between 0 and 83 percent. Generally Route 7 has been constructed to good structural standards.

Route 16 is part of the Trans Canada Highway, connecting Route 2 at Aulac to Cape Tormentine. It is comprised of two highway segments totalling 51.9 km in length. Route 16 is a two lane facility, located in rolling terrain. Lane widths are approximately 3.7 metres with 3 metre wide shoulders. Percent no passing zones range between 30 and 53 percent. The structural base of this route is generally adequate.

2.3 Level of Service

Traffic volumes, particularly trucks, have increased substantially on the study network over the last number of years. Table 2.1 provides a concise summary of traffic volume ranges on the four major highway routes. The average annual daily traffic (AADT) on Route 1 ranges from 6,900 to 16,895 vehicles, with the higher volumes experienced on the four lane highway section in the Saint John area. Average annual daily truck traffic (AADTT) levels generally exceed 1,000 vehicles. During the thirtieth highest hour of the year (the design hourly volume) traffic volumes vary between 715 and 2,025 vehicles along Route 1.

The AADT along Route 2 ranges between a low of 3,315 and a high of 9,775, however, most highway segments are experiencing AADT levels of 5,000 to 6,000 vehicles. Truck traffic levels are between 445 and 1,420 vehicles daily. Design hourly volumes along Route 2 are between 465 and 1,370 vehicles, with the higher values on highway segments in the vicinity of the major urban areas.

Traffic volumes along Route 7 range from a low of 3,230 to a high of 9,800 AADT. The highest values are being experienced near Fredericton and Saint John. Similar characteristics are also exhibited by the AADTT values along Route 7, which range between 390 and 1,175 trucks. Between 360 and 925 vehicles hourly are experienced on this route during the thirtieth highest hour.

Route 16 is the least utilized portion of the study highway network, with AADT values less than 3,000 vehicles and AADTT levels around 300 trucks.

Figure 2.2 presents the distribution of average annual daily truck traffic values per route segment throughout the study network. These levels are colour coded in four intervals, less than 500, 501 to 750, 751 to 1,000 and greater than 1,000. Figure 2.2 clearly reveals the substantial truck traffic presently utilizing the various highway segments, particularly between Saint John and the Nova Scotia border.

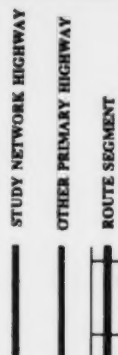
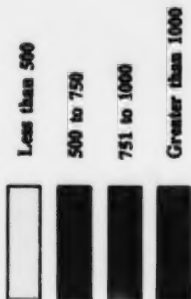
Table 2.1

STUDY NETWORK RANGE OF EXISTING 1988 TRAFFIC CHARACTERISTICS

Route	Distance (km)	AADT	AADTT	Design Hourly Volume Range
1	80.3	6,900 - 16,895	970 - 1,145	715 - 2,025
2	552.1	3,315 - 9,775	445 - 1,420	465 - 1,370
7	96.8	3,230 - 9,800	390 - 1,175	360 - 925
16	51.9	2,140 - 2,930	160 - 305	330 - 500

LEGEND:

AADTT



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FIGURE 2.2
AVERAGE ANNUAL DAILY
TRUCK TRAFFIC (AADTT)

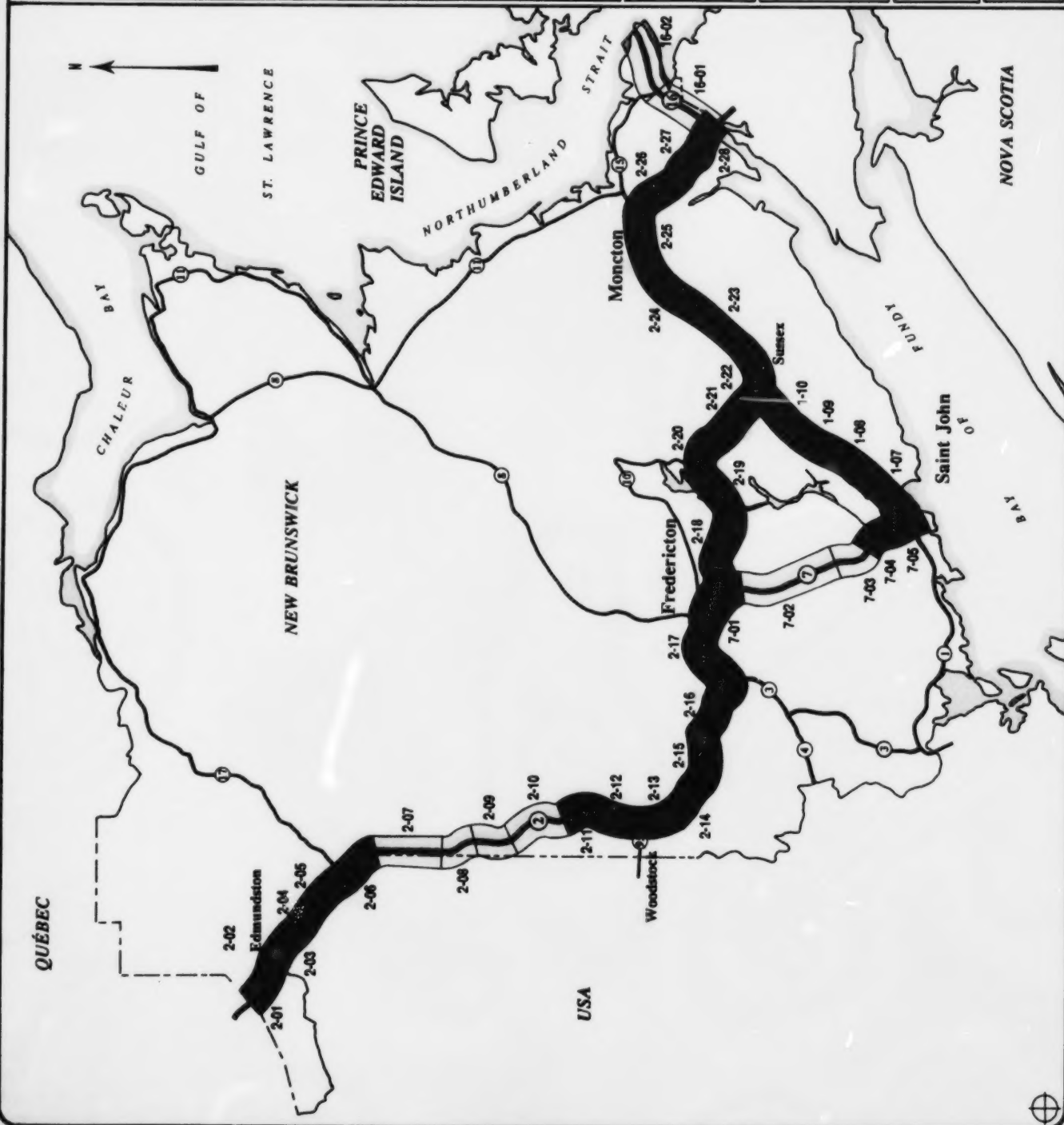
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PROJECT #: S37-11

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The existing levels of service for all study network highway segments have been computed. Sixty-one percent of Route 1 is presently operating at level of service E. In other words, these highway segments are operating at or approaching capacity. The remaining 39 percent of Route 1, is a four lane facility and is operating at level of service B.

The majority of Route 2 between the Quebec and Nova Scotia borders is operating below level of service C, which, for the purpose of this study, is the minimum level of service prior to highway segments being identified for improvements. More specifically, only 1.7 percent is at level of service A and 4.1 percent at level of service C. A total of 39.8 percent of Route 2 is at level of service D, 51.6 percent is at or near capacity, level of service E, while the remaining 2.8 percent is operating at level of service F. Less than 6 percent of the Trans Canada Highway Route 2 segments are operating at level of service C or better.

Existing level of service on Route 7 is considerably better than Route 2. Presently, 56.9 percent of Route 7 is operating at a level of service C. The remaining 43.1 percent is below this level of service, with 16.8 percent at D and 26.3 percent at E.

Route 16 has been subdivided into two equal distant highway segments. The highway segment between Port Elgin and Cape Tormentine is operating at level of service D, while the other segment between Aulac and Port Elgin is at level of service C.

Figure 2.3 illustrates the existing level of service of the highway segments throughout the study network. Those segments operating at level of service C or better are shown in one colour, yellow.

2.4 Highway Safety

The previous section described the current level of service status of the study highway network. Basically the analysis indicated that a large majority of the network is presently operating below level of service C, the design standard selected for the purpose of this study. In this section highway safety is addressed in terms of accident rates and roadside development per route segments.

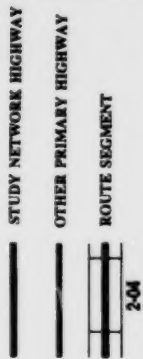
2.4.1 Accident Rates

Accident rates are expressed in terms of the number of accidents per million vehicle kilometres (mvk) and are based on a three year average. Figure 2.4 displays the ranges of average accident rates recently experienced on the study network.

Accident rates on Route 1 range from 0.22 accidents per mvk on the four lane section to 1.07 accidents per mvk on the two lane segments. Accident rates on Route 2 range from 0.22

LEGEND:

LEVEL OF SERVICE



DRAWING TITLE:

FIGURE 2.3
EXISTING
LEVEL OF SERVICE

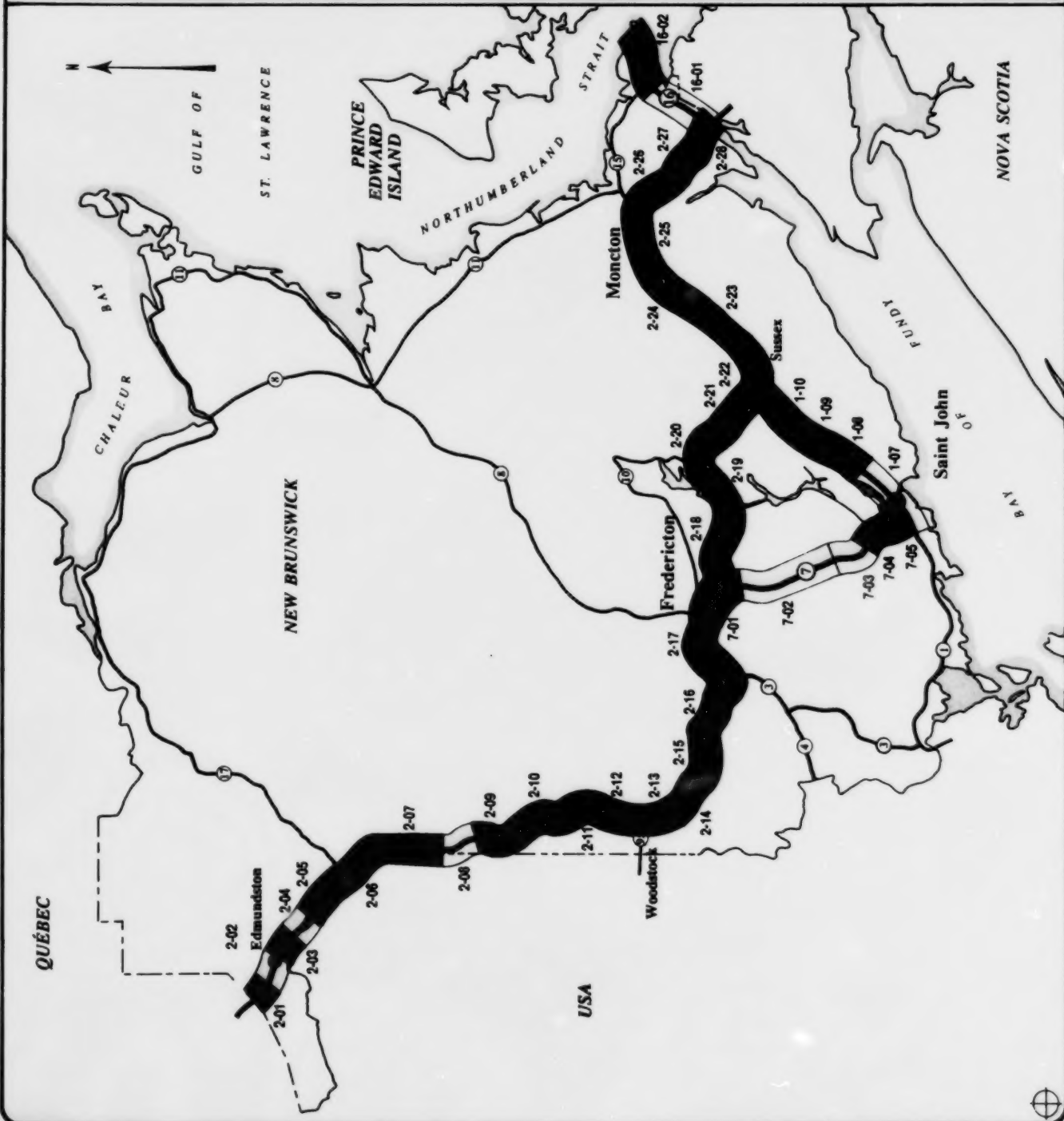
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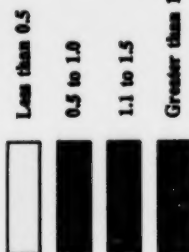
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LEGEND:

ACCIDENTS PER MILLION
VEHICLE KILOMETERS



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FIGURE 2.4
EXISTING AVERAGE
ACCIDENT RATES

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

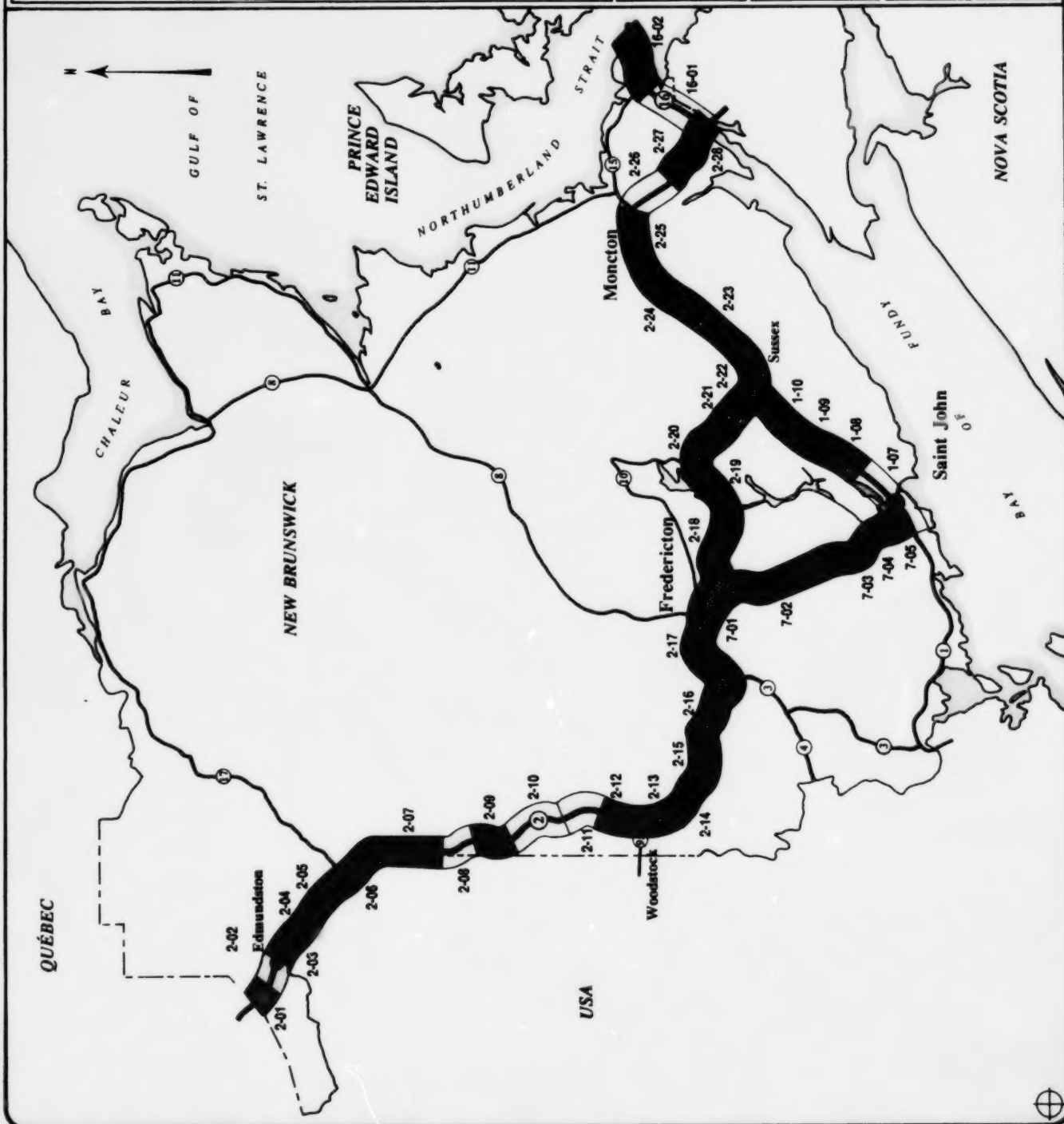
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accidents per mvk (a four lane facility), to the highest rate of 1.79 accidents per mvk. On Routes 7 and 16, the range in accident rates is 0.58 to 1.2 and 0.31 to 0.76 accidents per mvk, respectively.

There have been approximately 1,050 accidents per year on the study network, 73 percent of which occurred on the Trans Canada Highway Route 2. Approximately 28 percent of all accidents on the study network have involved fatalities or personal injuries to vehicle occupants.

2.4.2 Roadside Development

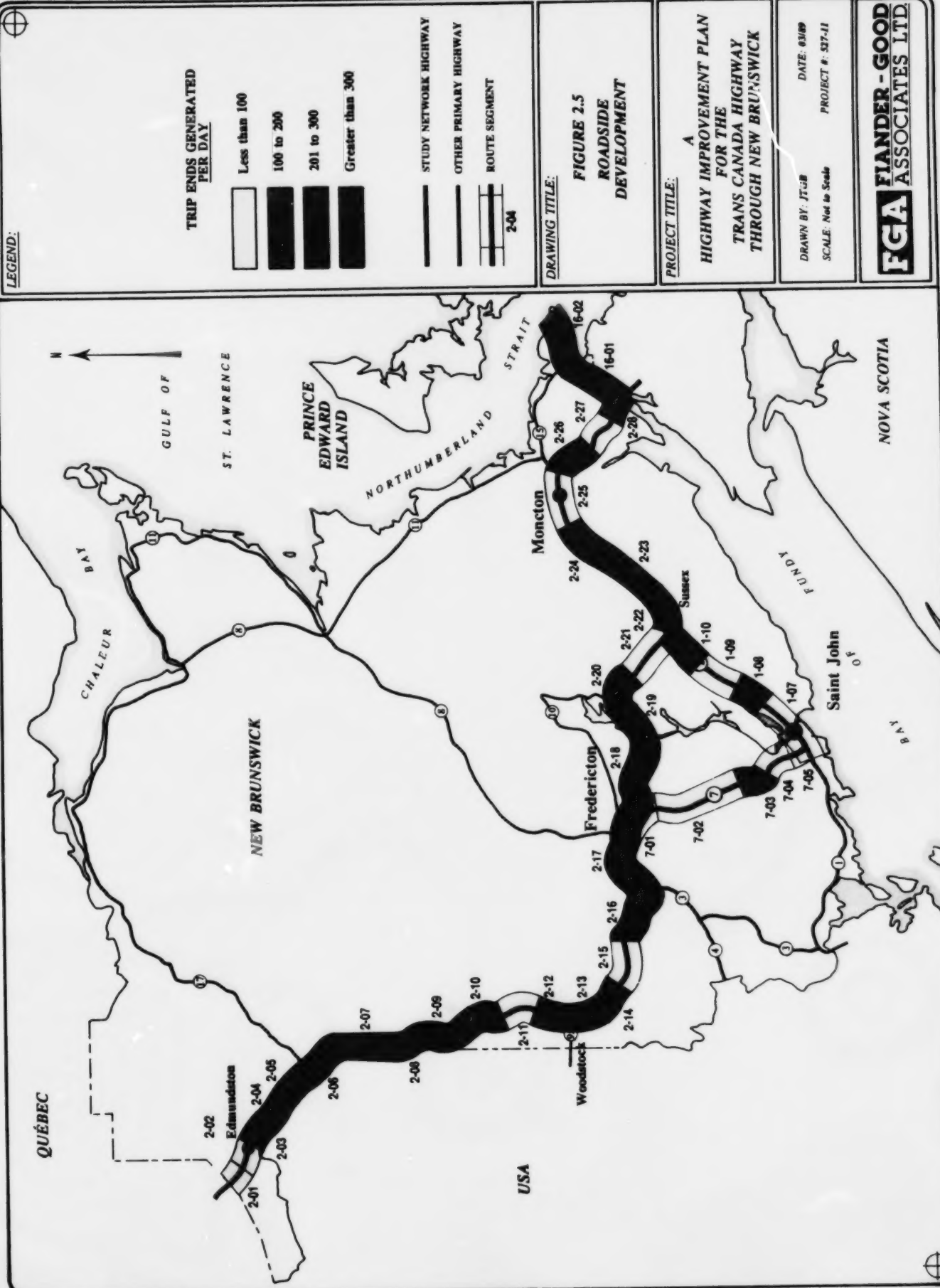
Another variable which relates to highway safety is the extent of roadside development along the study highway network. Most highway segments are not fully access controlled and have a number of direct private accesses to various types of residential, commercial and other business establishments. More specifically, there are over 5,000 private driveways with direct access to the Trans Canada Highway. These include access to 2,000 homes, 100 service stations, close to 40 motels and numerous other commercial establishments. In addition, there are over 400 at-grade intersections with connecting public roads.

To provide a common measure of roadside development activity along highway segments, each access location was converted to the number of daily trip ends (to and from) the type of establishment generates. This measure of activity was based on the Institute of Transportation Engineers Trip Generation Manual. For example, a service station generates approximately 135 trip ends daily per pump, whereas a single family household generates an average of 10 trip ends daily.

The number of daily trip ends generated per kilometre over each highway segment was then developed to describe the level of roadside development density. It should be noted that public accesses and at-grade intersections with other highways and streets along the various highway segments, have not been included as part of the roadside development variable.

Figure 2.5 illustrates this level of roadside development along the study network. The intensity of development along Route 1 generates from 20.5 to 146 trip ends per kilometre per day. Route 2 roadside development generates from 0 (a fully access controlled segment) to 843 trip ends per kilometre per day.

A large percentage of Route 7 is presently accessed controlled and as a result does not generate any trip ends. However, there is one highway segment which has over 210 trip ends generated daily per kilometre. Roadside development along Route 16 is relatively consistent, with approximately 100 trip ends generated per kilometre per day.



3.0 PROPOSED STUDY NETWORK IMPROVEMENTS

3.1 Forecast Traffic Levels

The major variable which influences when and to what extent highway improvements should be implemented, is traffic volumes. Growth in traffic volumes affects both level of service and accident occurrences. Therefore, to determine the future highway deficiencies of the study network, it is necessary that traffic volume increases be projected throughout the design period. Three separate traffic projections, a base case and low and high scenarios, have been produced to enable a sensitivity analysis of future deficiencies and improvement requirements.

In selecting the annual growth rate for the base case traffic projection scenario, two separate data sources were reviewed. These sources include forecasts produced by the Macroeconomic and Regional Analysis Branch of Transport Canada and the New Brunswick Department of Transportation annual traffic volumes data base.

Transport Canada prepares freight and passenger forecasts each spring and fall for regions throughout Canada and these forecasts are derived from the past and expected performance of the Canadian and regional economies and major commodity sectors. The latest freight forecasts for the Atlantic Region in the trucking industry (for-hire and private trucking) indicate annual increases of 2.2 percent between 1987 and 1996. Automobile traffic is projected to increase at a 2.7 percent annual rate.

The New Brunswick Department of Transportation has maintained traffic volume counts on an annual basis between 1965 and 1987 at 98 count stations in various locations along the study network. These counts indicate a higher overall average annual traffic growth rate for the study network at 3.73 percent. This, however, is skewed by urban area traffic growth rates of over 5 percent.

The following summarizes the base case, low and high forecast traffic growth scenarios as agreed with the Technical Steering Committee, and reflects differential rural and urban rates:

- o Base Case Scenario:
 - rural areas - auto - 2.7%
 - truck - 2.2%
 - urban areas - auto - 5.0%
 - truck - 2.2%
- o Low Growth Scenario:
 - rural areas - auto - 2.0%
 - truck - 1.5%
 - urban areas - auto - 4.0%
 - truck - 1.5%
- o High Growth Scenario:
 - rural areas - auto - 3.5%
 - truck - 3.0%
 - urban areas - auto - 6.0%
 - truck - 3.0%

3.2 Proposed Highway Network Improvements

The current study network status, including the existing level of service of the various route segments, was summarized in Chapter 2.0. This section identifies the projected level of service and associated deficiencies which will be experienced on the highway network throughout the design period (1988 to 2008) based on the traffic projections. This analysis assumes the geometric characteristics will remain constant and the highway segments are not upgraded.

3.2.1 Projected Deficiencies

Table 3.1 summarizes the projected levels of service and deficiencies which will result if no improvements are implemented during two future ten year periods (1998 and 2008). Figure 3.1 graphically depicts the projected levels of service in 10 year increments for the base case traffic projection scenarios in comparison with the existing levels of service.

Figure 3.1 demonstrates that the level of service on Route 1 is projected to erode significantly if the highway segments are not upgraded. All of Route 1 will be operating below level of service C by year 2008. In fact almost 79 percent of Route 1 will be operating at level of service F, with the remaining portion at level of service E.

Figures 3.2 to 3.5 display the projected level of service analysis in 10 year increments for Routes 1, 2, 7 and 16. Figure 3.2 illustrates the percentage of the overall Route 1 distance per level of service for each traffic scenario for the years 1998 and 2008. This figure shows that Route 1 under all three scenarios is at the lower end of the level of service categories.

If no improvements are implemented along Route 2 between 1988 and 2008, the level of service is forecast to deteriorate significantly. This can be seen from Figure 3.1, as well as Table 3.1, for each of the traffic projection scenarios. For the base case scenario, all but 1.7 percent of Route 2 will be below level of service C by year 2008. Almost 65 percent will be operating at level of service E, 32 percent at level of service F and 2 percent at level of service D.

Figure 3.3 illustrates the 1998 and 2008 projected Route 2 level of service changes amongst the traffic projection scenarios. Under all three scenarios traffic flow conditions along Route 2 will be below level of service C both in 1998 and 2008, with the exception of 1.7 percent of Route 2.

The analysis indicates that all of Route 7 is forecast to be below level of service C by 1998. Figure 3.4 reveals that with any of the three traffic projection scenarios, operating conditions will be between levels of service D and F in 1998 and 2008, if Route 7 is not improved.

Table 3.1

LEVEL OF SERVICE ANALYSIS FOR
THE TRAFFIC PROJECTION SCENARIOS
WITHOUT PROPOSED HIGHWAY IMPROVEMENTS

Route Segment	Distance (km)	Existing 1988 Level Of Service	1998 Level of Service			2008 Level of Service		
			Base Case	Low Projection Scenario	High Projection Scenario	Base Case	Low Projection Scenario	High Projection Scenario
1-07	31.3	B	C	C	C	F	D	F
1-08	14.2	E	F	F	F	F	F	F
1-09	17.6	E	E	E	F	F	E	F
1-10	17.2	E	E	E	E	E	E	F
2-01	10.1	E	E	E	E	E	E	E
2-02	9.2	A	A	A	A	A	A	A
2-03	14.0	E	E	E	E	E	E	F
2-04	11.0	C	D	D	D	E	D	E
2-05	14.1	E	E	E	E	F	E	F
2-06	17.9	E	F	F	F	F	F	F
2-07	27.4	D	E	E	E	E	E	E
2-08	11.6	C	D	D	D	D	D	D
2-09	14.7	D	E	D	E	E	E	E
2-10	22.9	D	E	E	E	E	E	F
2-11	17.9	D	E	E	E	E	E	F
2-12	14.6	E	E	E	E	E	E	F
2-13	14.0	E	E	E	E	E	E	F
2-14	13.8	D	E	E	E	E	E	E
2-15	18.9	E	E	E	E	E	E	F
2-16	31.3	E	E	E	E	E	E	F
2-17	26.1	E	E	E	F	F	F	F
2-18	52.8	D	D	D	D	E	E	E
2-19	14.7	D	E	E	E	E	E	E
2-20	23.2	D	E	E	E	E	E	E
2-21	32.4	D	D	D	D	E	E	E
2-22	22.5	E	F	F	F	F	F	F
2-23	16.3	E	F	F	F	F	F	F
2-24	36.1	E	F	F	F	F	F	F
2-25	23.1	E	E	E	E	E	E	E
2-26	15.4	F	F	F	F	F	F	F
2-27	17.7	E	F	F	F	F	F	F
2-28	8.4	E	E	E	E	F	E	F
7-01	16.9	E	F	F	F	F	F	F
7-02	46.0	C	D	D	D	E	D	E
7-03	9.1	C	D	D	D	D	D	E
7-04	16.3	D	D	D	D	E	E	E
7-05	8.5	E	E	E	F	F	F	F
16-01	25.9	C	C	C	D	D	D	D
16-02	26.0	D	D	D	E	E	E	E

FIGURE 3.1
PROJECTED LEVELS OF SERVICE WITHOUT
PROPOSED HIGHWAY IMPROVEMENTS

ROUTE SEGMENT	DESCRIPTION	LEVEL OF SERVICE		ROUTE SEGMENT	DESCRIPTION	LEVEL OF SERVICE	
		1988	1998			1988	1998
2-01	QUE BORDER TO ST-JACQUES			1-07	LORNEVILLE TO GONDOLA PT		
2-02	ST-JACQUES TO HEBERT BLVD			1-08	GONDOLA PT. TO HAMPTON		
2-03	HEBERT BLVD TO RIV-VERTE			1-09	HAMPTON TO NORTON		
2-04	RIV-VERTE TO STE-ANNE			1-10	NORTON TO SUSSEX		
2-05	STE-ANNE TO ST-LEONARD			7-01	FREDERICTON TO OROMOCTO		
2-06	ST-LEONARD TO GR. FALLS			7-02	OROMOCTO TO MT DOUGLAS RD		
2-07	GR FALLS TO AROOSTK RIV			7-03	MT DOUG. RD TO WESTFLD BP		
2-08	AROOSTK RIV TO PER-ANDVR			7-04	WESTFIELD BP TO GR BAY BP		
2-09	PERTH-ANDVR TO R-DE-CHUTE			7-05	GR BAY BP TO SAINT JOHN		
2-10	R-DE-CHUTE TO FLORENCVILL						
2-11	FLORENCVILLE TO HARTLAND			16-01	AULAC TO PT ELGIN		
2-12	HARTLAND TO JACKSONVILLE			16-02	PORT ELGIN TO C TORMNTINE		
2-13	JACKSONVILLE TO RTE 103						
2-14	RTE 103 TO MEDUCTIC						
2-15	MEDUCTIC TO POKIOK						
2-16	POKIOK TO LONGS CREEK						
2-17	LONGS CRK TO FREDERICTON						
2-18	FREDERICTON TO JEMSEG						
2-19	JEMSEG TO MILL COVE						
2-20	MILL COVE TO COLES ISLAND						
2-21	COLES ISLAND TO SUSSEX						
2-22	SUSSEX TO FIVE POINTS						
2-23	FIVE PTS TO PETITCODIAC						
2-24	PETITCODIAC TO MONCTON						
2-25	MONCTON TO SCAUDOU						
2-26	SCAUDOU TO MEMRAMCOOK						
2-27	MEMRAMCOOK TO SACKVILLE						
2-28	SACKVILLE TO N.S. BORDER						

LEVEL OF SERVICE: A to C

D E F

FIGURE 3.2

OVERALL PROJECTED LEVEL OF SERVICE
ANALYSIS FOR ROUTE 1
(1998 AND 2008)

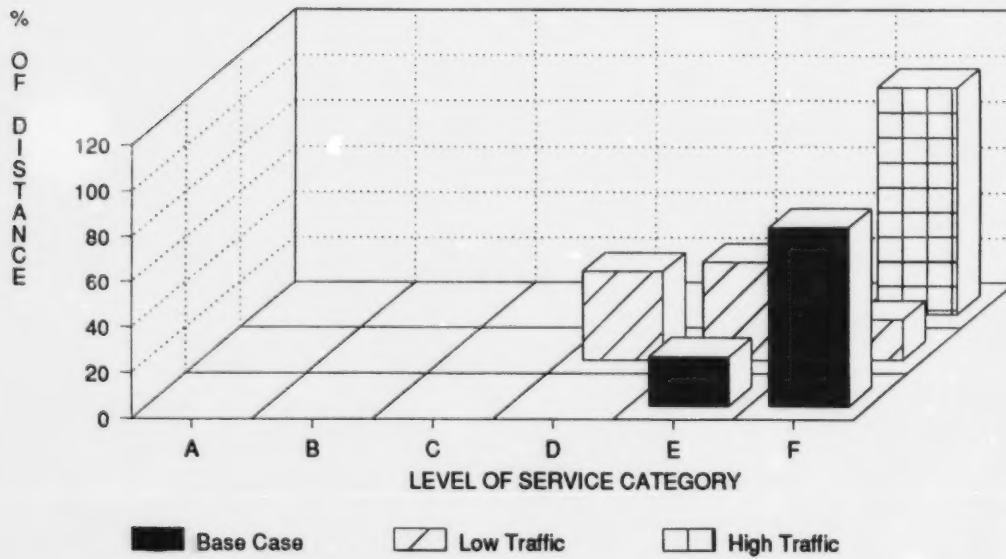
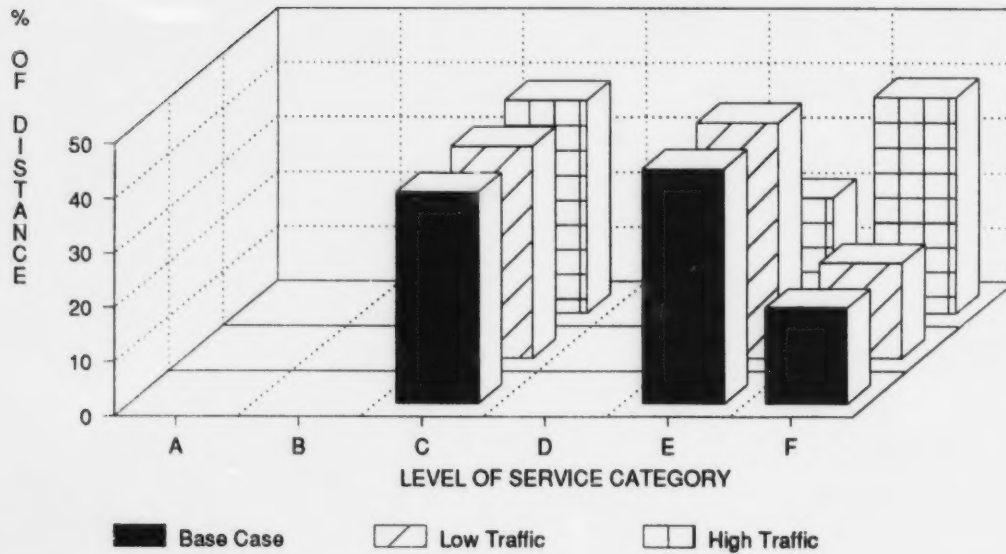


FIGURE 3.3

OVERALL PROJECTED LEVEL OF SERVICE
ANALYSIS FOR ROUTE 2
(1998 AND 2008)

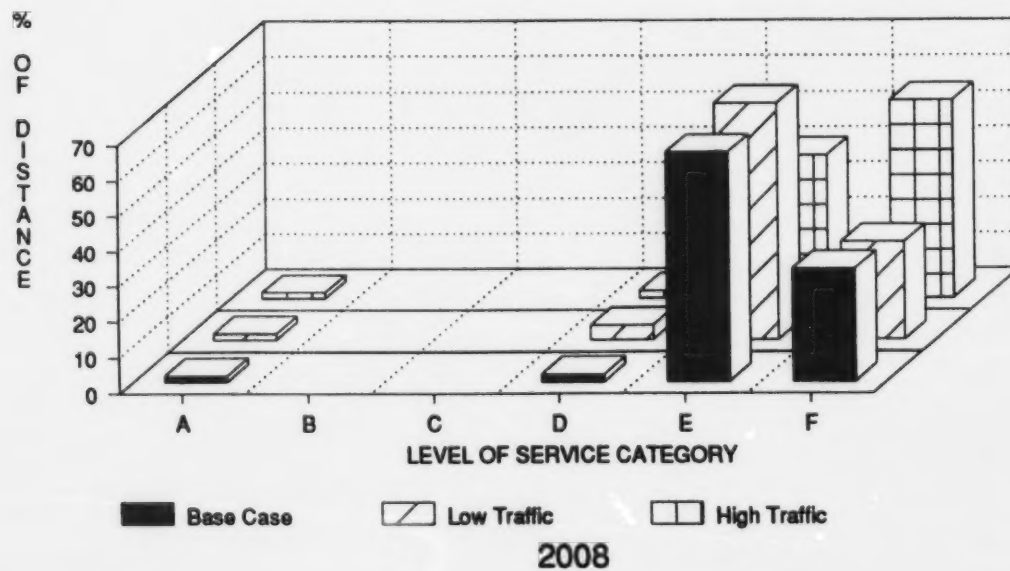
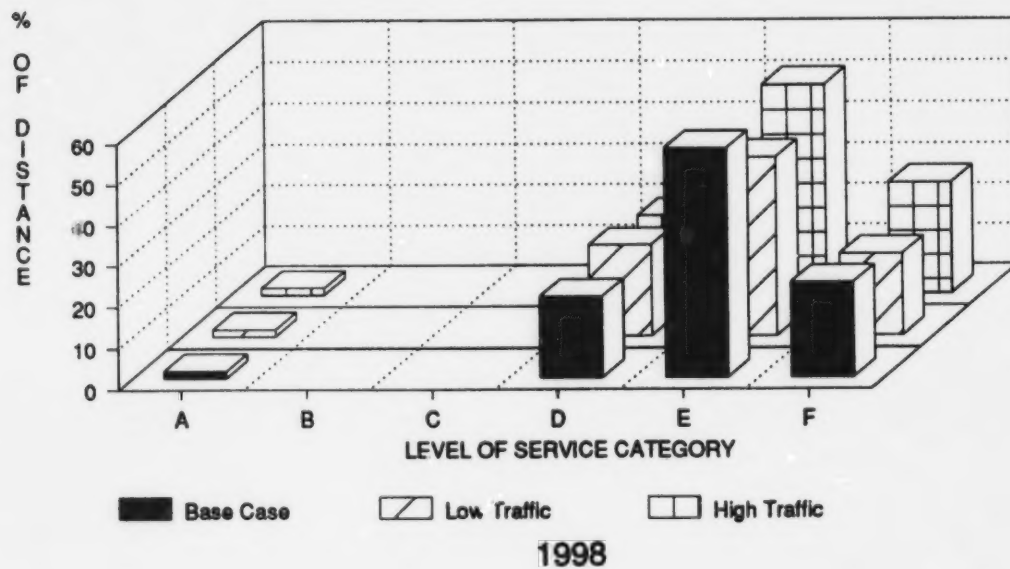
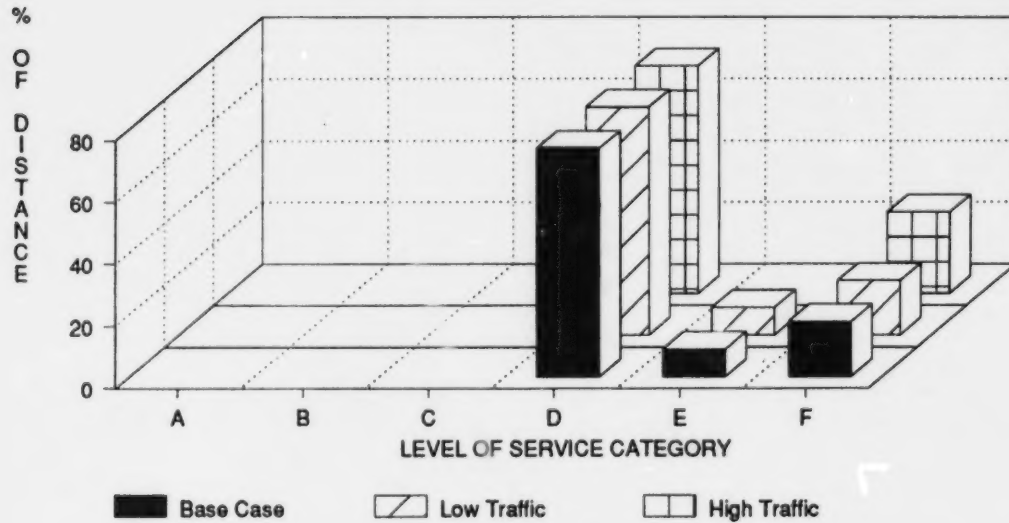
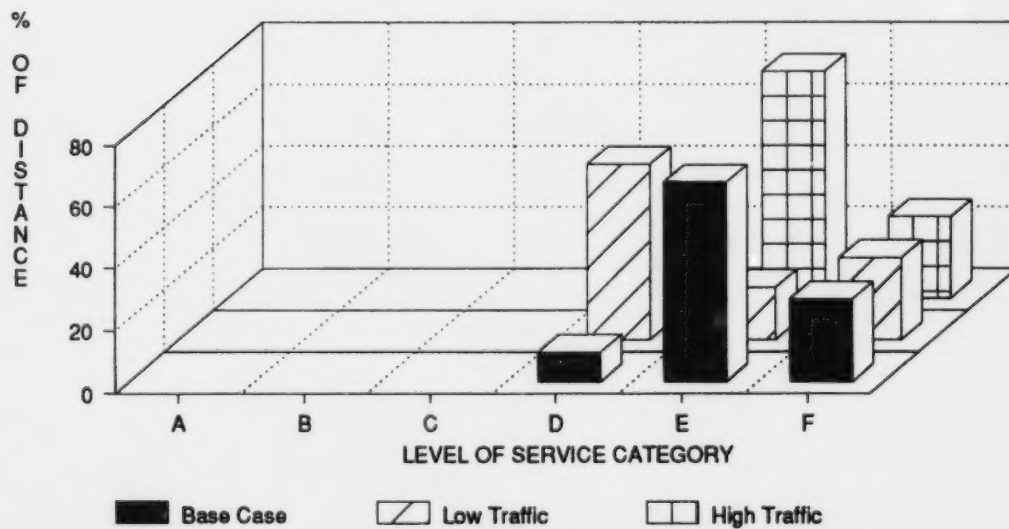


FIGURE 3.4

OVERALL PROJECTED LEVEL OF SERVICE
ANALYSIS FOR ROUTE 7
(1998 AND 2008)

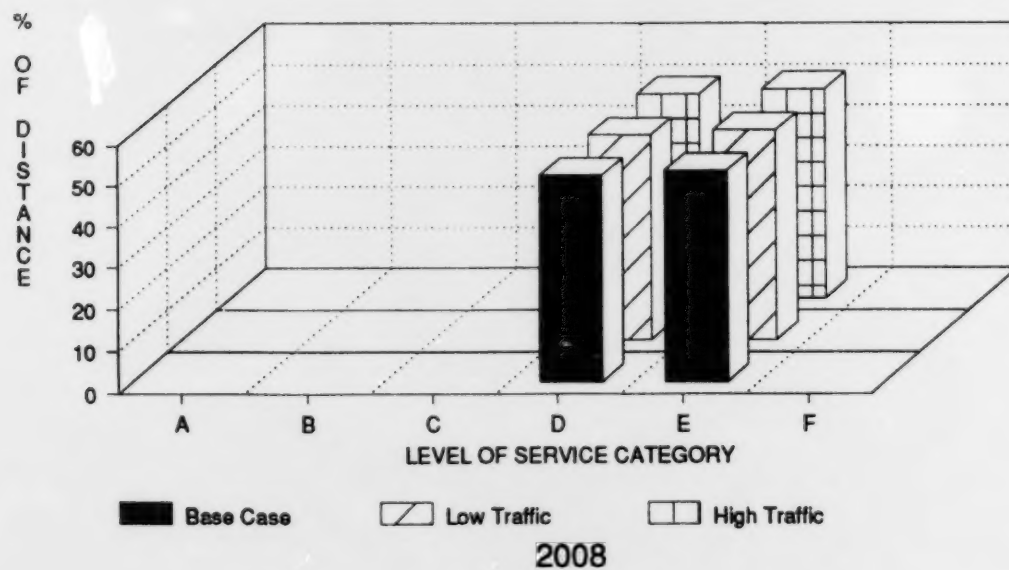
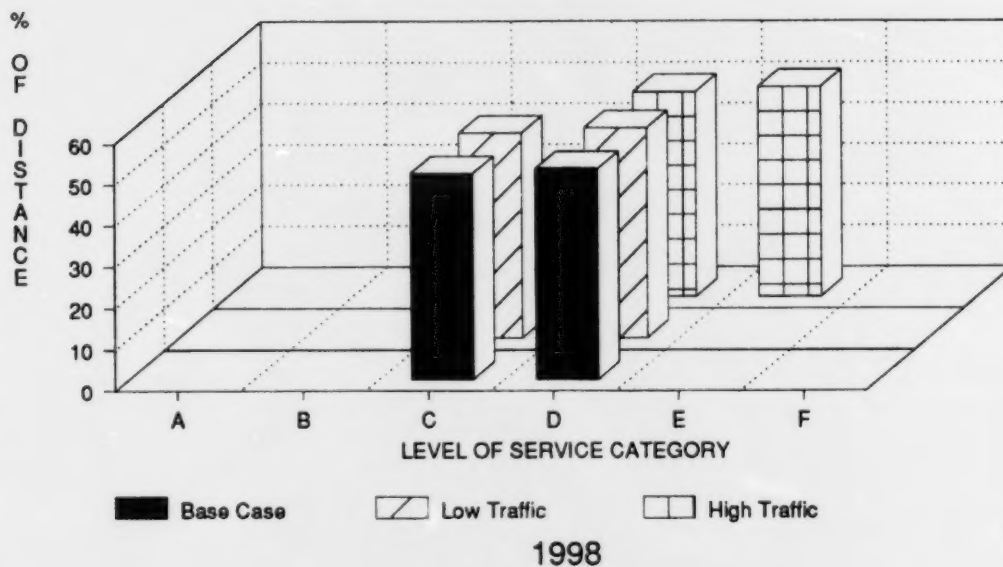


1998



2008

FIGURE 3.5
OVERALL PROJECTED LEVEL OF SERVICE
ANALYSIS FOR ROUTE 16
(1998 AND 2008)



Under the base case traffic projection Route 16 will be operating below level of service C by 2008. In 1998, it is estimated approximately 50 percent of Route 16 will be below the level of service C operating standard selected for this study. Figure 3.5 shows the changes in level of service in 1998 and 2008 for all three traffic projections.

It is evident that much of the study highway network is presently operating below level of service C and an increasing proportion is projected to fall below level of service C if the study network is not upgraded during the design period.

3.2.2 Proposed Improvements

It is clear from the analysis of existing and projected levels of service that the study network presently requires, and will require upgrading to safely and adequately handle traffic demand. The majority of the study network is already well below level of service C, the design standard for this study.

Figure 3.6 shows the condition of the study network in year 2008 if a do-nothing approach is taken and proposed improvements are not implemented. Without improvements only 1.2 percent of the study network will be operating at level of service C or better. Six percent will be at level of service D, while the remaining 92.8 percent will be either level of service E (62.4 percent) or F (30.4 percent).

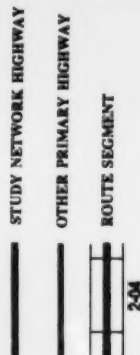
Although no detailed analysis was completed on stop gap measures, such as provision of climbing and left turning lanes, or other options such as passing lanes, lane and shoulder widening, or vertical and horizontal alignment improvements, it appears that they will not be sufficient to accommodate existing and projected traffic demand. It was decided that to adequately accommodate existing and projected traffic demand the study network should be upgraded to a four lane divided facility that is fully access controlled. In one case, it could be necessary to upgrade an existing four lane divided segment from Lorneville to Gondola Point to six lanes and possibly eight lanes.

Based on upgrading to a four lane divided facility with full access control, a projected "with improvements" level of service analysis was completed. Figure 3.7 summarizes the projected 2008 level of service on the study network for the base case traffic projection scenario if the proposed improvements are implemented.

With the upgrading, the entire study network is forecast to operate at level of service C or better, with the exception of highway segment 1-07, which will operate at level of service D. This segment is located in the Saint John area and the traffic projections utilized a higher annual rate of growth because of past experience in this urban environment. It appears reasonable at this time to upgrade this facility from a four lane divided to a six lane divided segment and to monitor its level of service operating conditions subsequent to any further improvements.

LEGEND:

LEVEL OF SERVICE



2-04

DRAWING TITLE:

FIGURE 3.6
PROJECTED LEVELS OF SERVICE
IN 2008 WITHOUT PROPOSED
HIGHWAY IMPROVEMENTS

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

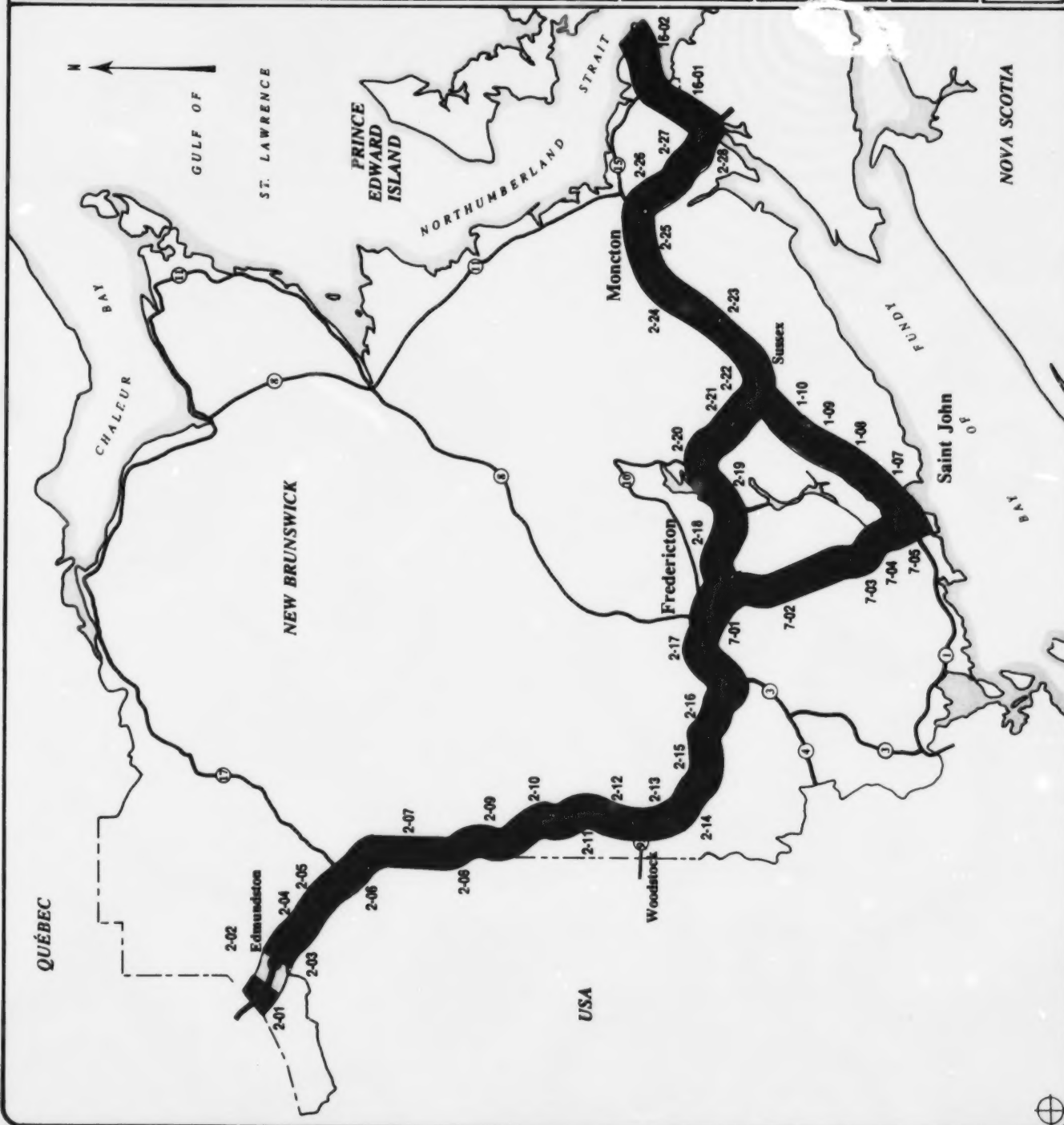
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DATE: 03/09

SCALE: Not to Scale

PROJECT #: S17-11

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LEGEND:

LEVEL OF SERVICE

A to C



D



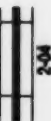
STUDY NETWORK HIGHWAY



OTHER PRIMARY HIGHWAY



ROUTE SEGMENT



2-04

DRAWING TITLE:

**FIGURE 3.7
PROJECTED LEVELS OF SERVICE
IN 2008 WITH ALL PROPOSED
HIGHWAY IMPROVEMENTS
COMPLETED**

PROJECT TITLE:

**A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK**

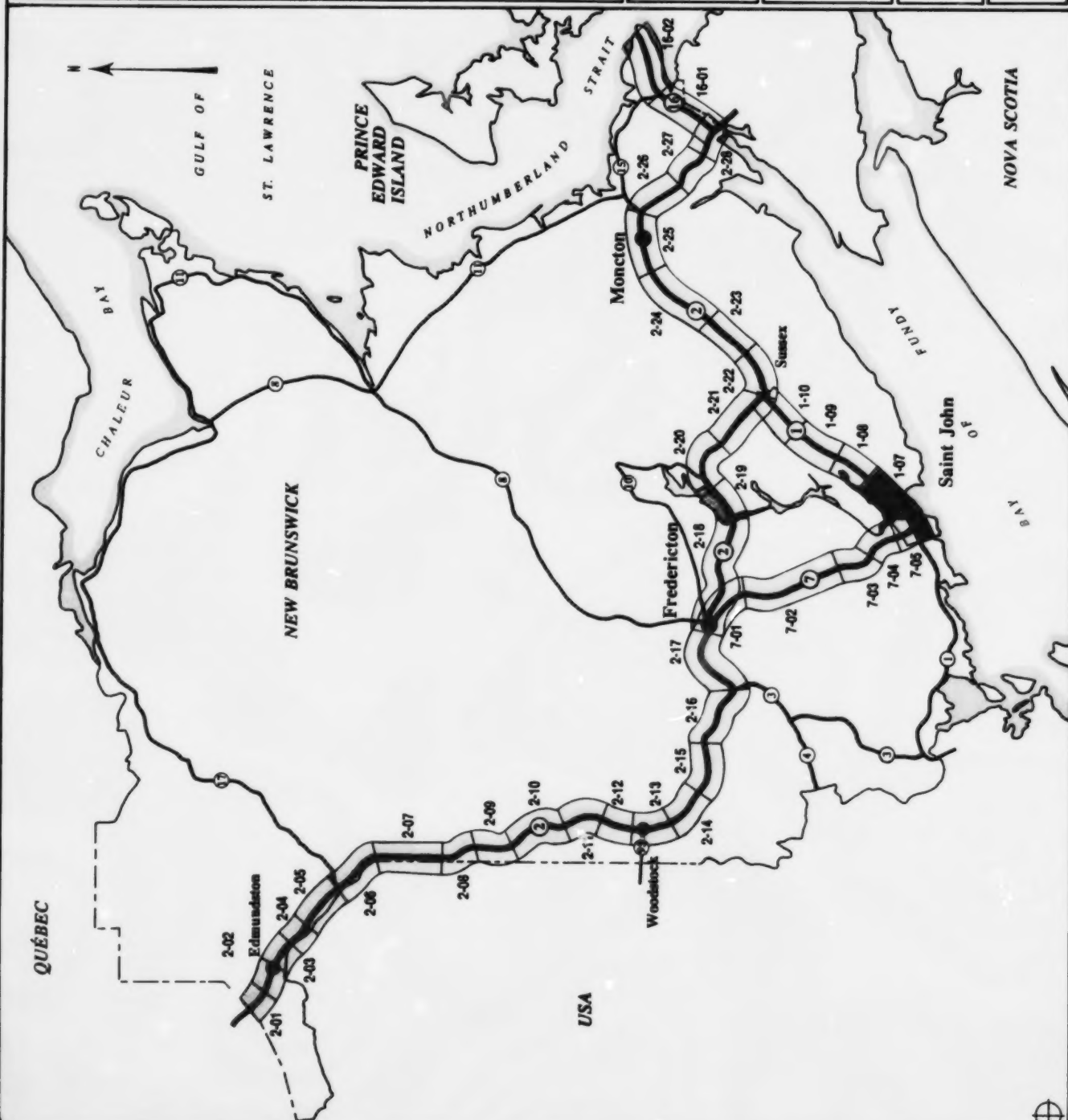
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DATE: 03/09

SCALE: Not to Scale

PROJECT #: 337-J1

**FGA FLANDER - GOOD
ASSOCIATES LTD.**



To summarize, the upgrading of the study network to a four lane divided facility with full access control will significantly improve traffic flow conditions and will accommodate existing and forecast traffic demand. Over 90 percent of the study network will operate at level of service B or A. Five percent will operate at level of service C, while only 4 percent will experience level of service D conditions, if the proposed improvements are implemented.

3.3 Improvement Costs

This section presents the cost estimates in 1988 dollars associated with upgrading the study network to a four lane divided facility with full access control. These costs can be considered Class D estimates and have been derived from unit costs of recently awarded primary highway contracts in New Brunswick. These estimates reflect either construction of a new four lane divided by-pass route with median or twinning of the existing alignment divided by a median. The decision as to whether to by-pass or twin the study area network has been taken from work previously completed by the Planning Branch of the Department of Transportation. This alignment decision was based on a thorough investigation of the feasibility of utilizing the existing alignment or by-passing, where development is extensive.

The unit cost breakdowns are as follows:

Costs ('000's x \$1988)		
<u>Category</u>	<u>By-Pass</u>	<u>Twinning</u>
Interchange	\$3,500	\$2,500
Grade Separation	1,750	850
Bridge (Per m ²)	1	1.1
Grading (Per km)	800	400
Gravel (Per km)	350	175
Paving (Per km)	800	400

Table 3.2 summarizes the total cost for upgrading each route segment of the study network. These cost figures do not include land acquisition, legal or engineering fees. It should be noted that highway segment 1-07 is presently a four lane divided facility and will require upgrading to six lanes within the study time frame. Highway segment 2-02 is presently four laned, which will be sufficient throughout the study period, and therefore, no cost is afforded to it. Highway segment 7-01 has not been assigned a cost to avoid double counting, as it has been incorporated with highway segment 2-18.

Table 3.2

STUDY HIGHWAY NETWORK ROUTE SEGMENT COST ESTIMATES
(\$ 1988)

Highway Segment	Description	Length (km)	Total Cost (000's)
1-07	Lorneville to Gondola Point	31.3	56,350
1-08	Gondola Point to Hampton	13.1	38,820
1-09	Hampton to Norton	17.3	33,055
1-10	Norton to Sussex	17.7	37,883
2-01	Quebec Border to St. Jacques	10.1	16,475
2-02	St. Jacques to Hebert Blvd.	9.3	0
2-03	Hebert Blvd. to Riviere-Verte	16.3	40,731
2-04	Riviere-Verte to Ste-Anne	11.1	26,755
2-05	Ste-Anne to St. Leonard	14.1	48,710
2-06	St. Leonard to Grand Falls	19.3	58,748
2-07	Grand Falls to Aroostook River	27.5	65,426
2-08	Aroostook Rv. to Perth-Andover	11.6	21,078
2-09	Perth-Andover to Riv-de-Chute	16.2	37,508
2-10	Riv-de-Chute to Florenceville	22.8	52,680
2-11	Florenceville to Hartland	18.0	46,625
2-12	Hartland to Jacksonville	14.6	39,745
2-13	Jacksonville to Route 103	14.0	20,173
2-14	Route 103 to Meductic	13.9	38,630
2-15	Meductic to Pokiok	18.8	21,885
2-16	Pokiok to Longs Creek	31.2	66,695
2-17	Longs Creek to Fredericton	26.2	65,670
2-18	Fredericton to Jemseg	48.9	109,083
2-19	Jemseg to Mill Cove	14.8	40,330
2-20	Mill Cove to Coles Island	23.2	56,320
2-21	Coles Island to Sussex	29.9	62,442
2-22	Sussex to Five Points	22.5	50,405
2-23	Five Points to Petitcodiac	16.2	23,003
2-24	Petitcodiac to Moncton	36.1	96,500
2-25	Moncton to Scoudouc	23.2	27,378
2-26	Scoudouc to Memramcook	15.4	21,725
2-27	Memramcook to Sackville	17.7	22,913
2-28	Sackville to N.S. Border	8.5	23,252
7-01	Fredericton to Oromocto	12.4	0
7-02	Oromocto to Mt. Douglas Rd.	46.0	49,537
7-03	Mt. Douglas Rd. to Westfield	9.3	31,711
7-04	Westfield to Grand Bay	18.4	29,998
7-05	Grand Bay to Saint John	6.6	11,282
16-01	Aulac to Port Elgin	25.9	67,111
16-02	Port Elgin to Cape Tormentine	26.0	59,538

Table 3.3 presents the estimated cost, percent twinning versus by-pass, number of interchanges, number of grade separations and number of bridges for each route. The total cost to upgrade the entire study network, including land acquisition, legal and engineering fees is estimated at \$1,979 million.

The majority of Routes 1 and 7 can be upgraded along the existing alignment. Most of Route 16 will require by-passing of the existing alignment. Approximately 60 percent of Route 2 will require by-passing of existing alignments.

The highway upgrading projects will include the construction of 93 interchanges, 86 grade separations and 41 bridges. These structure requirement estimates are based on the preliminary study network corridor plans of the Department of Transportation.

Table 3.3

SUMMARY OF COST ESTIMATE TO
UPGRADE STUDY NETWORK
(\$ 1988)

Route	Distance (km)	Cost Estimate (000's)	Percent Twinning	Percent By-Pass	Number of Interchanges	Number of Grade Separations	Number of Bridges
1	80.3	166,114	63.7	36.3	9	16	3
2	552.1	1,200,885	42.4	57.6	72	60	27
7	96.8	122,528	90.0	10.0	7	3	10
16	51.9	126,649	6.7	93.3	5	7	1
Sub-Total		1,616,176					
Land Acquisition and Legal Fees		200,000					
Engineering		<u>162,984</u>			—	—	—
TOTAL		1,979,160			93	86	41

4.0 ECONOMIC IMPORTANCE OF STUDY HIGHWAY NETWORK

The four primary highways of the study network provide a crucial economic and social function in connecting the regions within New Brunswick, as well as connecting New Brunswick and the other Atlantic Provinces to the rest of Canada and the U.S.A.

The benefits of the study network can be viewed from two basic standpoints:

- 1). the economic benefits derived from the highway system's provision of economic and social travel linkages interconnecting regions within, to and from and through New Brunswick; and
- 2). the anticipated net benefits of improving the study highway network to four lane divided highway status achieved through reduced accidents, travel time and vehicle operating costs and enhanced economic development, as well as the short term commercial and employment impacts of the construction projects.

To fully understand the basis and context of the economic benefits attained from the study highway network, it is necessary to review the economic areas served by the existing and improved facility.

4.1 Economic Profile of Highway Network Service Area

For the purpose of this study, the highway network service areas have been categorized as follow:

1. the three major urban centres of New Brunswick:
 - o Moncton,
 - o Saint John, and
 - o Fredericton;
2. the four regions of New Brunswick:
 - o Northwest New Brunswick - Madawaska, Victoria and Carleton Counties,
 - o Southwest New Brunswick - York, Sunbury, Queens, Kings, Saint John and Charlotte Counties,
 - o Southeast New Brunswick - Albert, Westmorland and Kent Counties, and
 - o Northeast New Brunswick - Northumberland, Gloucester and Restigouche Counties;

3. the four Atlantic Provinces:
 - o New Brunswick,
 - o Nova Scotia,
 - o Prince Edward Island, and
 - o Newfoundland;
4. the other six provinces and two territories of Canada; and
5. the United States of America.

In general, New Brunswick and the other Atlantic Provinces have been economically disadvantaged in comparison with the other Canadian Provinces. The relatively small population and market size, limited resource and industrial base and geographical separation from the mainstream Central Canadian economy have all contributed to regional disparity between the Atlantic Provinces and the rest of Canada. Attempts to equalize economic growth and stability through various government equalization, subsidy and incentive programs have benefitted the region, yet disparity persists.

Each of the three major cities provides a complementary role in the New Brunswick economy. The City of Saint John is the major industrial centre and ocean port of New Brunswick. Moncton is the principal distribution centre of the Maritimes, as a result of its ideal location on the Trans Canada Highway and CN Rail lines with direct links to the U.S.A. and the rest of Canada. Fredericton is the Provincial capital and Provincial centre of public administration and professional services. Incomes and commercial activities in these urban centres exceed those in the other more rural areas of the Province, but still lag behind national levels. Close to half (48 percent) of the Province's personal income and 45 percent of total retail sales are generated within these three urban areas.

In general, per capita retail sales of New Brunswick and the Atlantic Provinces are much closer to national averages than are their respective per capita incomes. This indicates that personal expenditures by Atlantic Region residents, as a proportion of their personal incomes, exceed national average levels. This implies that lesser proportions of Atlantic Region personal incomes are available for private savings and investment than would be generally found elsewhere in Canada. It also implies that a lower tax base is available for public investment in public services and infrastructure, such as highway improvement.

4.2 Demand Profile of Highway

Figure 4.1 presents the nine major economic and socio-economic links which connect New Brunswick's major urban centres and regions, the Province and the Atlantic Region to the rest of Canada and the U.S.A.

LEGEND:

- STUDY NETWORK HIGHWAY
- OTHER PRIMARY HIGHWAY
- ROUTE SEGMENT

2-04

DRAWING TITLE:

FIGURE 4.1
MAJOR ECONOMIC
AND SOCIOECONOMIC
HIGHWAY LINKS

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

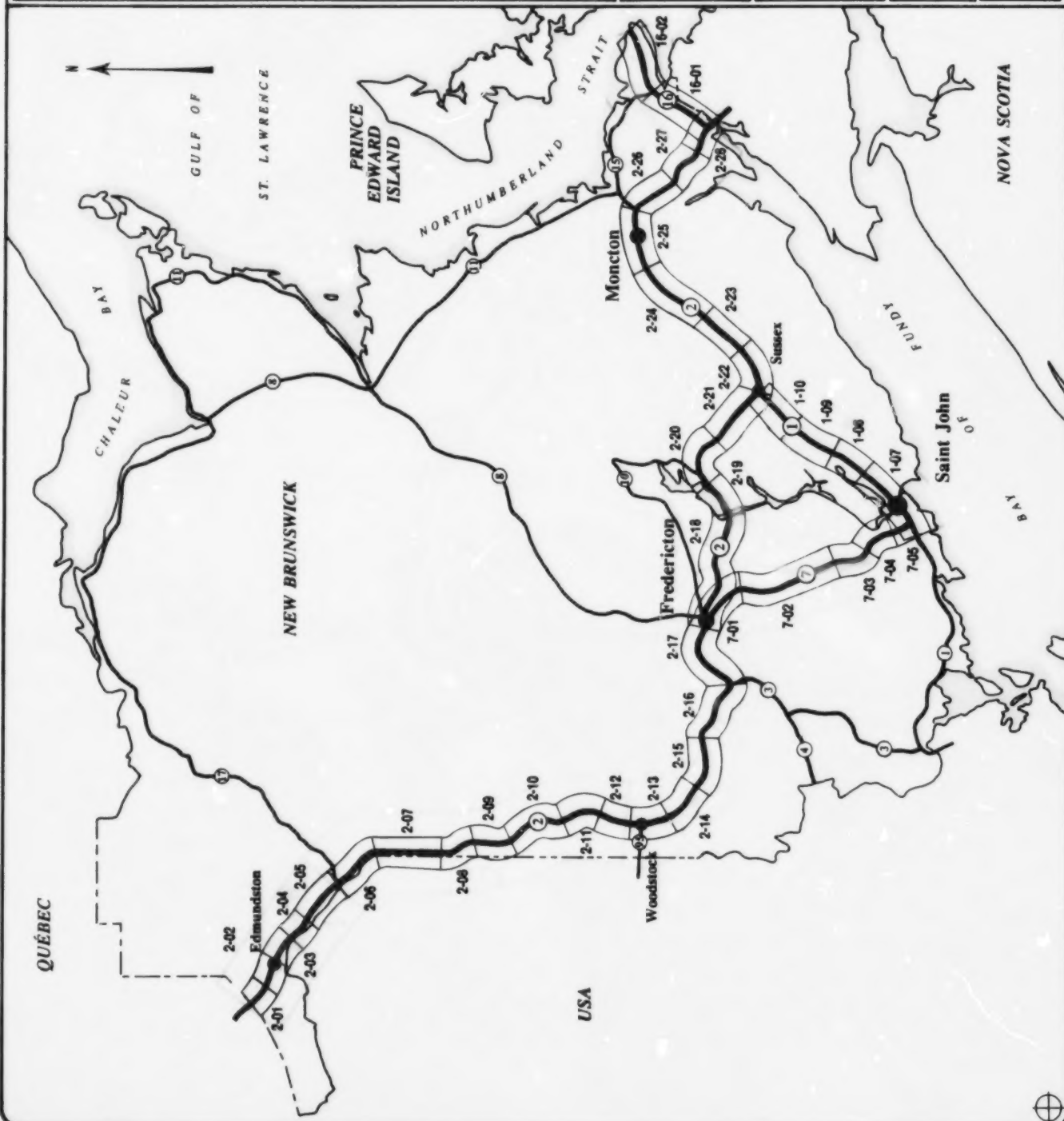
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DATE: 03/89

SCALE: Not to Scale

PROJECT #: 517-11

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Each major link provides an economic function to New Brunswick, the Atlantic Region and/or Canada through its derived demand for vehicular passage of goods and services to, from, within and through the Province. Industrial and commercial truck traffic levels on the network represent the spatial interaction of goods production and consumption activities exchanged among economic areas. Similarly, commercial and personal auto travel levels establish economic, social and cultural linkages among the ascribed areas. These travel levels among economic areas implicitly describe the level of derived demand for the highway links which connect them.

To evaluate the relative derived economic and socio-economic demand for each major link of the study highway network, two regional origin-destination travel data files were updated to 1988 levels and utilized -

*1979 Atlantic Provinces Origin-Destination Travel Survey, and
1984 Atlantic Provinces Truck Origin-Destination Survey.*

Vehicular travel profiles were established from the origin-destination surveys to determine the spatial interaction among the areas served by the study network as shown in Figure 4.2 for:

- o Intra/Inter-City New Brunswick Travel - travel among and within the three major urban centres of Fredericton, Moncton and Saint John;
- o Intra/Inter-Regional New Brunswick Travel - travel among and within the four regions of New Brunswick;
- o Extra-Provincial New Brunswick Travel - travel between New Brunswick and the other Atlantic Provinces, the rest of Canada and the United States; and
- o Through New Brunswick Travel - travel between the other Atlantic Provinces and the rest of Canada and the U.S.A.

The number of truck trips and automobile trips per trip purpose was accounted for each vehicular travel profile. The sum of truck trips and commercial auto trips was used as a proxy variable representative of economic demand. Similarly, the sum of auto trips for holiday, pleasure and other trips was used as a proxy to socio-economic demand. These trips were assigned to the study network to determine the relative extent of the derived economic and socio-economic demand for each major link of the study network.

Table 4.1 summarizes the relative economic and socio-economic demand for the nine major links of the study network. The trips include only trips from one economic region to another and exclude local travel within each area to represent the spatial interaction and demand for the connecting routes. Therefore, these trips should not be confused with traffic levels on the major

LEGEND:

TRIP TYPE

Inter-City

Inter-Regional

Extra-Provincial

Through Province

REGIONAL BOUNDARY

STUDY NETWORK HIGHWAY

OTHER PRIMARY HIGHWAY

ROUTE SEGMENT

2-04

DRAWING TITLE:

FIGURE 4.2
TRAVEL ROUTE
PROFILES

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

DRAWN BY: JTG

DATE: 03/89

SCALE: Not to Scale

PROJECT #: 537-11

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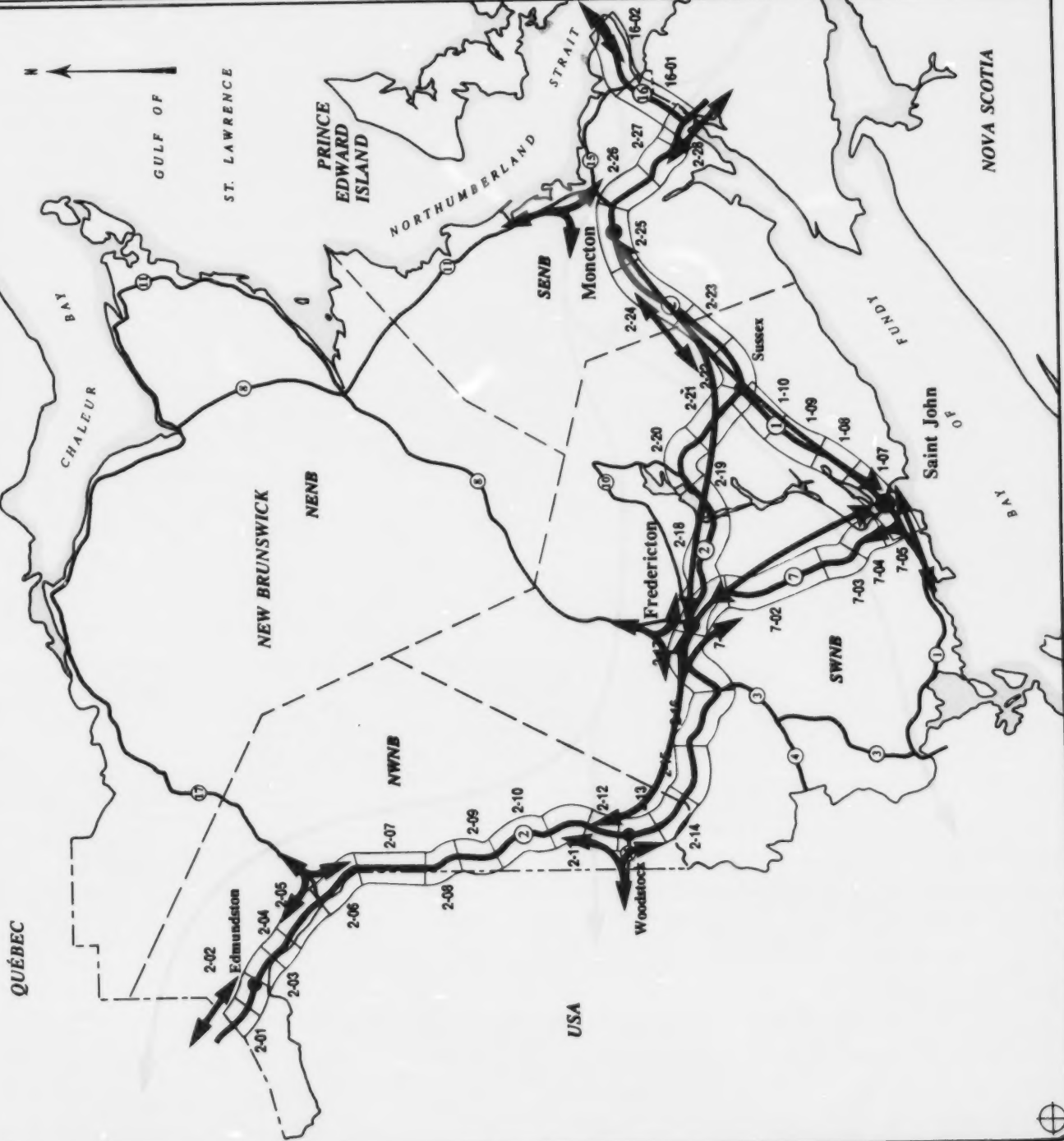


Table 4.1

ECONOMIC AND SOCIO-ECONOMIC BASED TRIPS DEMAND EVALUATION
OF STUDY MAJOR HIGHWAY LINKS (in hundreds)

Major Links:		Inter City Trips		Inter Region Trips		Extra-Provincial Trips		Through Province Trips		Total Trips		Ranking	
No.	Route	Description	Economic	Socio-Economic	Economic	Socio-Economic	Economic	Socio-Economic	Economic	Socio-Economic	Economic	Socio-Economic	Economic
1	2	Que. Border to St. Leonard	0	0	898	326	1,440	629	782	335	3,120	1,290	2
2	2	St. Leonard to Woodstock	0	0	1,175	495	1,127	486	782	335	3,084	1,316	3
3	2	Woodstock to Fredericton	0	0	894	378	926	684	1,051	534	2,871	1,596	4
4	2	Fredericton to Sussex	394	82	622	356	602	596	1,051	534	2,669	1,568	5
5	2	Sussex to Moncton	1,209	242	428	180	657	620	1,068	645	3,362	1,687	1
6	2	Moncton to N.S. Border	0	0	120	51	1,031	805	987	559	2,138	1,415	6
7	7	Fredericton to Saint John	769	156	378	150	229	115	0	0	1,376	421	8
8	1	Saint John to Sussex	815	160	243	183	373	235	17	111	1,448	689	7
9	16	Aulac to Cape Tormentine	0	0	35	16	198	230	567	303	800	549	9

links. The economic and socio-economic based trips for each travel profile were summed for each major link of the study network to determine their relative demand.

The results indicate Route 2: Sussex to Moncton to be the major link of highest economic and socio-economic importance. This major link connects Moncton to Saint John and Fredericton, as well as Southeast New Brunswick and the other Atlantic Provinces with the rest of New Brunswick, Canada and the U.S.A.

4.3 Highway User Benefits

While a full economic evaluation of the proposed highway improvements is beyond the scope of this study, it should be acknowledged that users of the highway system will benefit directly from the four laning of the study network.

These user benefits are achieved as a consequence of upgrading the study network to four lane divided status from:

1. travel time savings from the higher level of service offered by the study highway network;
2. accident reduction from the improved geometrics, access control and traffic flow separation; and
3. vehicle operating cost savings through reduced fuel consumption from maintaining constant speeds, reduced tire wear from alignment improvements and reduced vehicle depreciation from the improved highway surface.

Reasonable estimates of travel time savings over the entire length of each highway route of the study network have been determined from the difference of existing and after improvement average times to traverse each route segment. These "before" and "after" improvement travel times are based on the average speed per level of service and distance of each route segment. It is estimated an average of 1 hour and 35 minutes will be saved for a trip on the Trans Canada Highway between the Nova Scotia and Quebec borders of New Brunswick.

Similarly, an average of approximately 11 minutes will be saved on a trip between Saint John and Sussex, 14 minutes between Saint John and Fredericton, and 7 minutes between Aulac and Cape Tormentine. It should be noted that since the level of service per route segment calculations are based on the thirtieth highest hour of yearly traffic, service levels reflect summer peak conditions. Therefore, these time savings of traversing the highways are indicative of the summer tourist season and other peak traffic flow conditions.

An estimate of the overall saving in travel time between the Quebec and Nova Scotia borders was also completed based on comparing the existing and after improvement posted speed limits. The time saving was estimated at approximately one-half hour.

Accident reductions have been predicted per million vehicle kilometres based on upgrading to a four-lane fully access controlled divided highway status. Reasonable estimates of the reduction in number of accidents on each highway route have been determined from the length, traffic levels and the "before" and "after" improvement accident rates of each route segment. The sum of the difference in average accidents occurring before and after the highway improvements for all route segments will provide the predicted accident reduction per route. Accident reduction has been predicted on two bases:

1. An assumed accident rate used by Transport Canada in evaluating prospective highway improvements in absence of known accident data in the HUBAM model. This accident rate of 0.578 accidents per million vehicle kilometres (mvk) for a fully access controlled divided highway was derived from the *Highway Investment Analysis Package (HIAP), Volume I Users Guide, Cambridge, Mass., 1976*.
2. The average of the three most recent years of accidents experienced on four existing four-lane divided highway sections in the Province on Route 1 and Route 15. This rate is 0.343 accidents per mvk.

It was decided that accident reduction estimates should be expected to range within the calculated numbers using these accident rates after upgrading the highway network to four-lane divided access controlled status.

The predicted average accident reduction for the entire length of the Trans Canada Highway Route 2 following improvements is between 226 and 492 accidents per annum. Similarly, the estimated average per annum reduction of accidents would range from 50 to 82 less accidents on Route 1, 65 to 106 less accidents on Route 7 and 5 to 12 less accidents on Route 16. In total the average annual number of accidents throughout the study highway network could be reduced by 346 to 692 accidents with the highway improvements. With an average fatality rate of 2.3 percent over the study network, this could save from 8 to 16 lives per year. Similarly, with 26 percent of accidents involving personal injuries to vehicle occupants, there could be an average annual reduction of 90 to 180 accidents.

4.4 Gross Economic Impact

In addition to the benefits gained by users of an improved study highway network, the public expenditures on highway construction will provide non-user benefits to the local and Provincial economies. These economic benefits will be realized through the direct expenditures on

construction materials, equipment and labourers. Indirect expenditures will subsequently be generated and employment created in other sectors of the economy from construction workers spending their earnings, businesses profiting and expanding from selling materials and equipment. These second order impacts are known as multiplier or spin-off effects. These impacts are typically realized during and shortly following (approximately within a year or two) the project life. Similar direct and indirect impacts result from the engineering design and legal services required for the projects. The extent of indirect impacts have been estimated using the Statistics Canada Input - Output Model at the Provincial level.

Table 4.2 summarizes the gross economic impacts resulting from the entire highway improvement program for the study network. The \$1.6 billion highway construction program will produce almost \$3 billion of economic activity in the Province and will generate over 22,000 person-years of new and retained employment. With engineering, legal and right-of-way expenditures included, direct and indirect expenditures will total almost \$3.5 billion, while direct and indirect employment will total over 26,000 person-years during and immediately subsequent to completion of the highway construction program. These estimates do not account for the displacement of economic activity in other sectors of the economy resulting from financing the proposed highway upgrading projects.

It should be noted that many other positive and some negative impacts will occur as a result of the study highway network improvements. Typically, property values are affected both positively in cases where accessibility is improved, and negatively if accessibility is reduced. There will be income and sales tax benefits to Federal and Provincial governments through increased revenues received from newly employed workers and manufacturing and sales tax revenues generated from material purchases. There will also be a reduction in unemployed skilled and unskilled labour directly in the construction sector, as well as indirectly in various industrial and service sectors serving the construction activities. The social impacts of any property expropriations and relocations may be either negative or positive to affected individuals.

Highway construction projects have proven to provide high economic impacts to the local areas adjacent to the projects. A very high proportion of highway construction materials (eg. aggregates) are obtained locally. Highway construction requires a relatively high proportion of unskilled labour which penetrates a highly underemployed segment of society.

Table 4.2

GROSS ECONOMIC IMPACTS OF STUDY HIGHWAY
NETWORK IMPROVEMENTS

Route Number	(\$ 1988 x 000)			Person-Years		
	Direct Highway Expenditures	Indirect Expenditures Generated	Total Direct & Indirect Expenditures	Direct Construction Employment	Indirect Employment Created	Total Direct & Indirect Employment
1	166,114	139,370	305,484	1,315	1,279	2,594
2	1,200,885	1,007,543	2,208,428	8,196	7,975	16,171
7	122,528	102,555	225,083	1,084	1,055	2,139
16	126,649	106,654	232,654	756	736	1,492
TOTAL CONSTRUCTION	1,616,176	1,355,473	2,971,649	11,351	11,045	22,396
ENGINEERING	162,984	101,180	264,164	1,976	1,343	3,319
LEGAL	20,000	11,460	31,460	229	80	309
RIGHT-OF-WAY PURCHASE	180,000	0	0	0	0	0
TOTAL IMPACTS	1,979,160	1,468,113	3,447,273	13,556	12,468	26,024

5.0 ROUTE SEGMENT PRIORITIZATION

The relative priority of the individual study network highway improvement projects entails a complex comparative evaluation of independent and non-additive variables specific to each route segment. It has been shown in this report that based on level of service criteria adopted for this project, most of the route segments presently require upgrading and many are long overdue. Others will soon require upgrading, while all but one of the route segments will require upgrading within the study time frame. However, level of service is but one factor when faced with the task of selecting which route segments should be given higher priority than others. Obviously, all route segments presently at less than desired levels of service cannot be upgraded at once. Therefore, other service, safety and economic factors must also be evaluated to establish the relative urgency to improve each route segment.

Essentially, the relative urgency of upgrading each route segment to four lane divided highway status has been determined by using a priority evaluation matrix computer analysis of several service, safety and economic factors. The results from this priority analysis have been used as the primary input in the development of the project construction implementation plans presented in the next chapter. It should be noted that for practical and logistic reasons, these project priority rankings will in some cases be superseded to avoid construction and/or traffic flow anomalies in the final highway improvement implementation plans.

5.1 Evaluation Model Methodology

The development of the highway route segment priority evaluation model, and selection of evaluation criteria and their relative weights, evolved within a feedback process with the Steering Committee members. Initially, nine evaluation criteria from the preceding analyses were examined, of which two were economic factors, three were service factors and four were safety factors. Through factor correlation analysis these evaluation criteria were reduced to five.

The five evaluation criteria selected for input to the route segment evaluation model, along with their source and data format, are described below, and summarized in Table 5.1.

1. Level of Service: Level of service codes were established for existing traffic and capacity levels and ranked from low to high (ie. LOS F to LOS A). Route segments with common level of service codes were then further ranked within each level of service according to their respective highest to lowest volume-to-capacity ratios. Any remaining ties were broken by assigning a higher rank to the segment which is projected to regress to a lower level of service first.
2. Truck Traffic: Average annual daily truck traffic per route segment data were ranked from highest to lowest.

Table 5.1

EVALUATION MODEL CRITERIA INPUT DATA

Highway Route Segment #	Description	Service Criteria		Safety Criteria		Economic Criteria Derived Demand (O/D Trips)
		Level of Service (LOS, v/c)	Truck Traffic (AADTT)	Accident Rate (/mvk)	Roadside Development (Trip Ends/Km/Day)	
1-07	Lorneville to Gondola Point	B, 0.430	1,059	0.22	35.6	2,137
1-08	Gondola Point to Hampton	E, 0.820	1,129	1.02	146.1	2,137
1-09	Hampton to Norton	E, 0.680	971	1.07	20.5	2,137
1-10	Norton to Sussex	E, 0.590	1,143	0.7	130.1	2,137
2-01	Quebec Border to St. Jacques	E, 0.581	602	0.88	35.1	4,410
2-02	St. Jacques to Hebert Blvd.	Presently Under Construction				
2-03	Hebert Blvd. to Riviere-Verte	E, 0.540	710	1.79	399.1	4,410
2-04	Riviere-Verte to Ste-Anne	C, 0.370	711	0.99	205.8	4,410
2-05	Ste-Anne to St. Leonard	E, 0.610	715	1.04	251.5	4,410
2-06	St. Leonard to Grand Falls	E, 0.780	1,125	0.64	196.0	4,364
2-07	Grand Falls to Aroostook River	D, 0.441	462	0.64	139.1	4,364
2-08	Aroostook Rv. to Perth-Andover	C, 0.321	448	0.41	110.2	4,364
2-09	Perth-Andover to Riv-de-Chute	D, 0.450	447	0.68	250.0	4,364
2-10	Riv-de-Chute to Florenceville	D, 0.490	469	0.41	110.1	4,364
2-11	Florenceville to Hartland	D, 0.440	970	0.49	3.4	4,364
2-12	Hartland to Jacksonville	E, 0.591	979	0.91	156.6	4,364
2-13	Jacksonville to Route 103	E, 0.600	976	0.8	158.4	4,467
2-14	Route 103 to Meductic	D, 0.520	719	0.83	323.7	4,467
2-15	Meductic to Pokiok	E, 0.580	689	0.67	74.8	4,467
2-16	Pokiok to Longs Creek	E, 0.570	590	0.6	111.3	4,467
2-17	Longs Creek to Fredericton	E, 0.770	813	0.96	407.9	4,467
2-18	Fredericton to Jemseg	E, 0.410	685	0.92	232.4	4,237
2-19	Jemseg to Mill Cove	D, 0.492	522	1.76	339.0	4,237
2-20	Mill Cove to Coles Island	D, 0.491	552	0.89	230.2	4,237
2-21	Coles Island to Sussex	D, 0.350	588	0.72	71.6	4,237
2-22	Sussex to Five Points	E, 0.771	1,326	0.61	391.7	5,049
2-23	Five Points to Petitcodiac	E, 0.760	1,203	0.58	133.3	5,049
2-24	Petitcodiac to Moncton	E, 0.860	1,178	0.67	339.6	5,049
2-25	Moncton to Scoudouc	E, 0.670	1,395	0.63	4.3	3,553
2-26	Scoudouc to Memramcook	F, 1.010	1,418	0.48	103.8	3,553
2-27	Memramcook to Sackville	E, 0.850	936	0.77	27.6	3,553
2-28	Sackville to N.S. Border	E, 0.540	1,042	0.97	842.7	3,553
7-01	Fredericton to Oromocto	E, 0.700	1,176	0.92	13.0	1,797
7-02	Oromocto to Mt. Douglas Rd.	C, 0.320	388	1.1	0.0	1,797
7-03	Mt. Douglas Rd. to Westfield	C, 0.310	455	1.2	212.0	1,797
7-04	Westfield to Grand Bay	D, 0.360	546	0.87	0.0	1,797
7-05	Grand Bay to Saint John	Presently Under Construction				
16-01	Aulac to Port Elgin	C, 0.250	161	0.31	101.7	1,349
16-02	Port Elgin to Cape Tormentine	D, 0.420	406	0.76	106.8	1,349

3. Accident Rate: The average annual accident rates (three year average) per route segment on a per million vehicle kilometres basis were ranked from highest to lowest.
4. Roadside Development: The number of trip ends per kilometre/per day generated by all private development access (excluding farm and woodlot accesses) to each route segment were ranked from highest to lowest.
5. Derived Demand: The total of economic and socio-economic based trips among regions, used as a proxy to the derived demand for each major link of the study network, were summed and ranked from highest to lowest. The route segments comprising each of the major links were assigned equal ranks.

The mechanics of the model are presented graphically in Figure 5.1. All route segments were assigned numeric ranks from highest to lowest for each evaluation criterion according to their relative position among the route segments input data. Each evaluation criterion was assigned a percentage weighting according to its prominence among all of the criteria. The resulting normalized criteria rankings were summed for each route segment and then ranked. This approach allowed non-additive data to be assessed in combination, while permitting analytical flexibility to establish the relative weight given to each criterion as a part of the priority rank assignment.

After reviewing the sensitivity of the results to different assigned criteria weights, it was the preference of the Steering Committee to assign each of the five evaluation criteria equal weight. Given that one criterion was economic and the other four criteria were split between service and safety factors, the resulting evaluation weights assigned to the criteria were:

Service Criteria: (Level of Service and Truck Traffic at 20% each) = 40%;
Safety Criteria: (Accident Rate and Roadside Development at 20% each) = 40%; and
Economic Criteria: (Derived Demand) = 20%.

5.2 Results of Priority Analysis

Table 5.2 presents the route segment ranks by each evaluation criteria and overall for all of the service, safety and economic factors. The overall route segment ranks form the basis of the funding level scenarios implementation plans developed in the next chapter. Route segment 2-24: Petitcodiac to Moncton ranked highest overall, while route segment 16-01: Aulac to Port Elgin ranked lowest.

FIGURE 5.1
EVALUATION MODEL - FORMAT

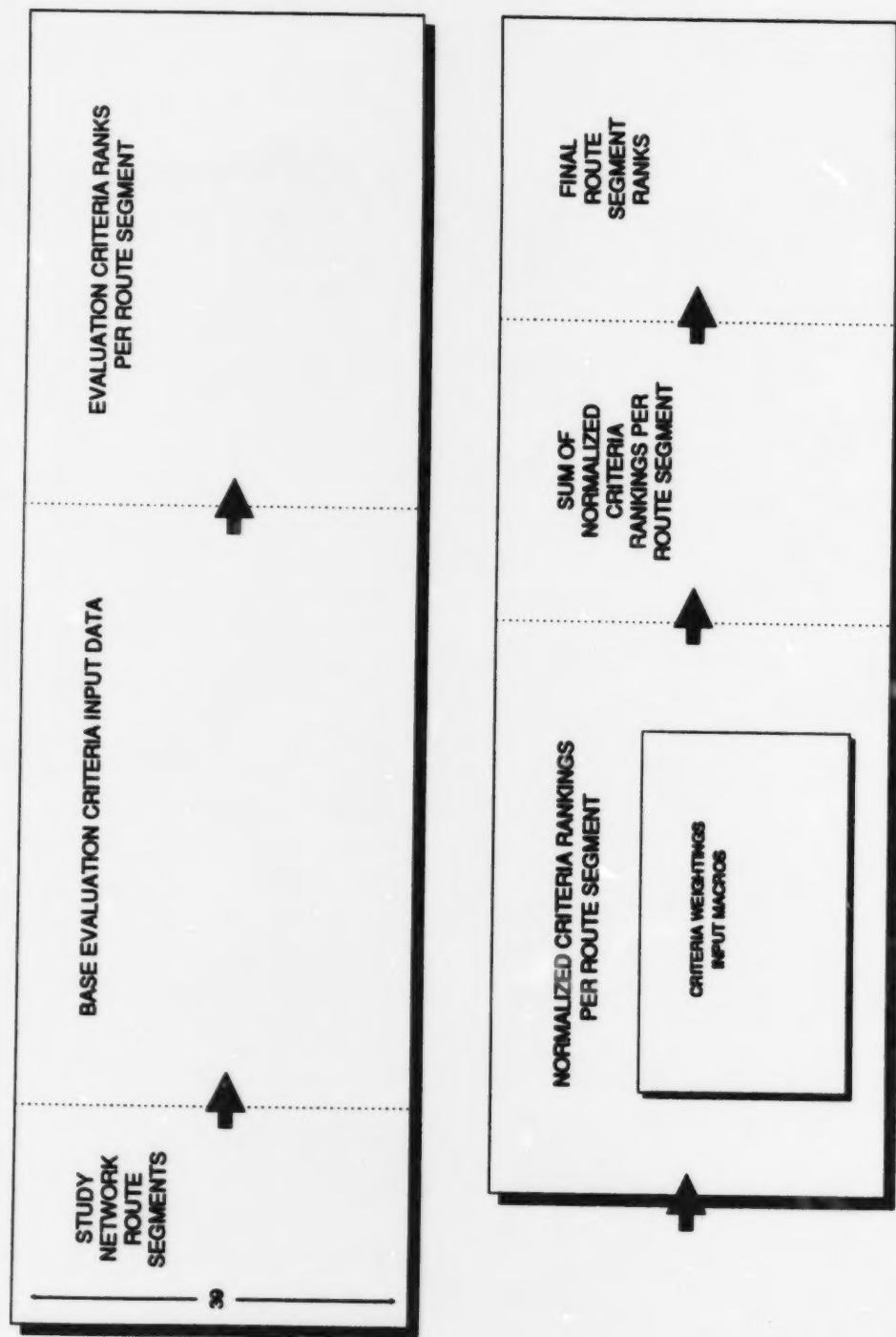


Table 5.2

FINAL ROUTE SEGMENT RANKS BY EVALUATION MODEL

Highway Route Segment #	Description	Service Criteria Only	Safety Criteria Only	Economic Criteria Only	Overall
1-07	Lorneville to Gondola Point	24	36	7	33
1-08	Gondola Point to Hampton	5	9	7	9
1-09	Hampton to Norton	9	17	7	17
1-10	Norton to Sussex	12	20	7	20
2-01	Quebec Border to St. Jacques	21	24	3	22
2-02	St. Jacques to Hebert Blvd.	Presently Under Construction			
2-03	Hebert Blvd. to Riviere-Verte	19	1	3	4
2-04	Riviere-Verte to Ste-Anne	25	7	3	14
2-05	Ste-Anne to St. Leonard	16	5	3	5
2-06	St. Leonard to Grand Falls	13	18	4	12
2-07	Grand Falls to Aroostook River	30	23	4	28
2-08	Aroostook Rv. to Perth-Andover	34	31	4	32
2-09	Perth-Andover to Riv-de-Chute	32	14	4	26
2-10	Riv-de-Chute to Florenceville	28	32	4	31
2-11	Florenceville to Hartland	19	37	4	29
2-12	Hartland to Jacksonville	14	12	4	11
2-13	Jacksonville to Route 103	14	15	2	8
2-14	Route 103 to Meductic	17	9	2	10
2-15	Meductic to Pokiok	17	29	2	21
2-16	Pokiok to Longs Creek	23	28	2	25
2-17	Longs Creek to Fredericton	9	4	2	2
2-18	Fredericton to Jemseg	22	8	5	16
2-19	Jemseg to Mill Cove	27	2	5	13
2-20	Mill Cove to Coles Island	25	11	5	23
2-21	Coles Island to Sussex	29	25	5	30
2-22	Sussex to Five Points	3	15	1	3
2-23	Five Points to Petitcodiac	4	27	1	7
2-24	Petitcodiac to Moncton	2	13	1	1
2-25	Moncton to Scoudouc	6	34	6	24
2-26	Scoudouc to Memramcook	1	33	6	15
2-27	Memramcook to Sackville	8	26	6	18
2-28	Sackville to N.S. Border	9	3	6	6
7-01	Fredericton to Oromocto	7	22	8	18
7-02	Oromocto to Mt. Douglas Rd.	36	19	8	34
7-03	Mt. Douglas Rd. to Westfield	35	6	8	27
7-04	Westfield to Grand Bay	30	30	8	35
7-05	Grand Bay to Saint John	Presently Under Construction			
16-01	Aulac to Port Elgin	37	35	9	37
16-02	Port Elgin to Cape Tormentine	33	21	9	36

6.0 HIGHWAY FUNDING AND IMPROVEMENT IMPLEMENTATION PROGRAMS

6.1 Provincial Highway Expenditure and Revenue Review

The purpose of this section is to provide a brief history of the provincial budget over the last 11 years for comparison with the Department of Transportation budget, as well as to review the provincial capital highway expenditures and federal/provincial cost sharing programs on the study network. In addition, provincial road related revenues are summarized.

Table 6.1 presents a comparison of the overall provincial expenditures budget with the Department of Transportation total expenditures budget. As can be seen from this table the Department of Transportation's share of the provincial budget has ranged from a high of 11.5 percent in 1979 to 8.8 percent in 1988. In 1987, Transportation's share dropped to 7.9 percent. Over the 11 year period the provincial budget has had a real (ie. constant dollars) increase of 40.7 percent, whereas the Department of Transportation has increased by only 8.7 percent.

A review of the overall highway expenditures budget presented in Table 6.2 indicates that in real terms, the actual capital expenditure budget has decreased since 1978. In the 1988 fiscal year, approximately \$165 million was spent on upgrading and/or constructing new highways and bridges. This is less than in 1978, when about \$174 million was spent. These expenditures include monies obtained from all federal/provincial agreements which were or are in place. The average annual capital expenditures over the last 3 years were just over \$155 million.

Table 6.2 also presents a breakdown of the annual combined federal/provincial and provincial only capital expenditures on the overall provincial arterial network versus the study network. It can be seen that a combination of federal/provincial and provincial capital expenditure programs has averaged (in constant 1988 dollars) over \$60 million annually in the past three years on the arterial highway network. This average annual value drops to \$20.8 million when only the study area highway network is considered.

Table 6.3 summarizes the annual provincial expenditures, as apart from its contribution to federal/provincial cost shared programs, from 1978 to 1988. The province spent an average of \$18.7 million annually in constant 1988 dollars on the arterial network and \$11.8 million annually on the study network over the last three years.

The estimated cost of upgrading the study network is \$1,979 million, or approximately \$99 million annually over a 20 year time frame and \$132 million annually over a 15 year time frame. Given that there has been an average annual federal/provincial and provincial investment in the study network of \$20.8 million per annum in the last three years, there exists a significant shortfall in the annual upgrading expenditures requirement. About 21 percent of the highway improvements would be completed at this level of funding over a 20 year period.

Table 6.1

A COMPARISON OF THE OVERALL PROVINCIAL BUDGET WITH THE
DEPARTMENT OF TRANSPORTATION BUDGET
(EXPENDITURES 000'S)

Year ¹	Provincial Budget (Constant 1988\$)	D.O.T. Budget (Constant 1988\$)	% of Provincial Budget
1978	2,446,116	278,191	11.4
1979	2,447,632	281,497	11.5
1980	2,442,445	255,563	10.5
1981	2,474,256	257,445	10.4
1982	2,586,976	252,441	9.8
1983	2,960,422	266,883	9.0
1984	3,032,002	242,914	8.0
1985	3,217,996	269,583	8.4
1986	3,235,130	284,502	8.8
1987	3,256,996	256,333	7.9
1988	3,441,319	302,334	8.8

Source: Public Accounts

¹ Fiscal Year ending March 31.

Table 6.2

COMBINED FEDERAL/PROVINCIAL AND PROVINCIAL CAPITAL EXPENDITURES
ON THE PROVINCIAL HIGHWAY NETWORK (000'S)

Year ¹	<u>Provincial Highway Network</u>		<u>Provincial Arterial Network</u>		<u>Study Network</u>	
	Current \$	Constant 1988\$	Current \$	Constant 1988\$	Current \$	Constant 1988\$
1978	89,368	173,868	32,517	63,263	12,136	23,611
1979	97,710	174,171	35,162	62,677	14,523	25,888
1980	92,240	149,256	39,756	64,330	17,767	28,749
1981	102,392	147,327	45,259	65,121	20,856	30,009
1982	104,482	135,515	27,921	36,214	16,854	21,860
1983	121,067	148,548	26,873	32,973	11,738	14,402
1984	105,709	124,364	26,939	31,693	8,731	10,272
1985	133,975	151,384	52,878	59,749	14,875	16,808
1986	153,626	166,803	75,863	82,370	24,590	26,699
1987	128,493	133,708	38,107	39,653	14,275	14,854
1988	165,034	<u>165,034</u>	59,607	<u>59,607</u>	20,820	<u>20,820</u>
ANNUAL AVERAGE OVER THE LAST THREE YEARS		155,182		60,543		20,791

Source: Department of Transportation and Public Accounts.

¹ Fiscal year ending March 31.

Table 6.3

PROVINCIAL ONLY CAPITAL EXPENDITURES
ON THE PROVINCIAL HIGHWAY NETWORK (000'S)

Year ¹	Provincial Arterial Network		Study Network	
	Current \$	Constant 1988\$	Current \$	Constant 1988\$
1978	8,918	17,350	3,893	7,574
1979	5,277	9,406	1,963	3,499
1980	6,992	11,314	2,291	3,707
1981	10,842	15,600	4,292	6,176
1982	6,337	8,219	3,321	4,307
1983	12,003	14,728	7,219	8,858
1984	8,116	9,548	4,881	5,742
1985	7,754	8,762	6,266	7,080
1986	16,505	17,921	10,000	10,858
1987	17,071	17,764	11,254	11,711
1988	20,909	20,909	12,809	12,809
ANNUAL AVERAGE OVER THE LAST THREE YEARS		18,865		11,793

Source: Department of Transportation

¹ Fiscal Year ending March 31.

Table 6.4 summarizes the road related revenues which have been collected by the Province over the last 11 years. The fuel taxes include revenues collected by the Department of Finance for both gasoline and diesel. Revenues under the Motor Vehicle Act and the Motor Carrier Act are collected by the Department of Transportation, and include such things as licensing and registration fees, fines and the unsatisfied judgement fund. Fuel tax revenues comprise the majority, almost 75 percent, of road related revenue collected.

The current 1988 taxation level has been utilized as the basis for determining the additional road related revenues necessary for the Province to finance the upgrading of the study area network on its own. It was identified previously that the upgrading of the study area network will require \$99 million annually over a 20 year period and \$132 million over a 15 year period. Taking into account the average annual provincial only expenditures to the study area network of \$11.8 million over the past 3 years, it can be determined that an additional \$87.2 million will be required annually from revenue sources based on the 20 year upgrading period, if the Province were to finance the project improvements by itself. Only 12 percent of the improvements would be completed at this level of funding over a 20 year period. If it is assumed the additional revenues will be obtained from the total road related revenues (including fuel tax, Motor Vehicle Act and Motor Carrier Act), then the 1988 revenues would have to be increased by 59.4 percent.

Another possible option would be to raise only the Motor Vehicle Act revenues which are primarily vehicle registrations and licensing fees. In this case, there would be a requirement for approximately a 221 percent increase over the current 1988 revenue level.

A third possibility would be to generate the required revenue from fuel taxes. To generate an additional \$87.2 million annually, the 1988 fuel taxes would have to be increased by almost 82 percent. In terms of cents per litre, the current tax rate of approximately 8 cents per litre, would have to be increased to 14.6 cents per litre.

On January 1, 1989 the Province of New Brunswick raised fuel taxes by 1.9 cents/litre on gasoline and 3.1 cents/litre on diesel fuel with the intent of earmarking the additional revenue generated from this fuel tax increase to a Highway Trust Fund. In addition, it has been proposed by the Department of Transportation that the provincial portion of funding from federal/provincial cost sharing programs be diverted to the Highway Trust Fund upon termination of the existing agreements.

6.2 Funding Level Scenarios

Four scenarios have been postulated as the funding level bases to the development of potential study highway network improvement implementation plans. Two scenarios demonstrate the inability to accommodate the required study highway network improvements under existing highway funding programs within a 20 year time frame. The remaining two scenarios assume

Table 6.4

ROAD RELATED PROVINCIAL REVENUES
(000'S)

Year ¹	Current \$			Total Revenue	
	Fuel Tax	Motor Vehicle Act	Motor Carrier Act	Current \$	Constant 1988\$
1978	50,714	18,264	317	69,295	134,815
1979	54,958	21,134	440	76,532	136,421
1980	61,107	21,222	441	82,770	133,932
1981	62,734	26,340	492	89,566	128,872
1982	69,709	27,252	544	97,505	126,466
1983	77,914	26,812	582	105,308	129,212
1984	98,981	27,746	585	127,312	149,779
1985	104,945	28,835	612	134,392	151,855
1986	114,074	29,796	608	144,478	156,871
1987	107,007	40,669	688	148,364	154,385
1988	106,421	39,513	795	146,729	<u>146,729</u>
ANNUAL AVERAGE OVER THE LAST THREE YEARS					152,662

Source: Public Accounts

¹ Fiscal Year ending March 31.

sufficient funding is provided to accommodate all study highway network improvements, differing only in the length of their implementation periods.

These scenarios are:

Scenario 1: This assumes that the Province will maintain its present level of annual expenditures on the study highway network from its Provincial Capital Expenditures Program until 2008, plus an annual allocation of \$8.0 million from the Highway Trust Fund. Based on an average of the three most recent annual Provincial capital expenditures (as given in Table 6.3 above) on the study highway network, the average annual funding level of this scenario is \$19.8 million in constant 1988 dollars. Over the 20 year program a total of \$395.9 million would be allocated to upgrading the study network. This level of funding would fulfil 20 percent of the proposed highway improvements at a total cost of \$1,979.2 million.

Scenario 2: This assumes that both the present levels of Provincial and Federal/Provincial annual capital expenditures on the study highway network will be maintained until 2008, plus an annual allocation of \$8.0 million from the Highway Trust Fund. Based on an average by the three most recent annual capital expenditures from the Provincial and Federal/Provincial programs on the study network (as given in Table 6.2 above) the average annual funding level of this scenario is \$28.8 million in constant 1988 dollars. Over the 20 year program a total of \$575.8 million would be allocated to upgrading the study network. This level of funding would fulfil 29 percent of proposed highway improvements at a total cost of \$1,979.2 million.

Scenario 3: This assumes that sufficient funding is available to eliminate all level of service deficiencies by the proposed upgrading of the entire study highway network to four lane divided status by 2008. Given the total highway improvement costs of \$1,979.2 million for the study network, this would entail an average annual expenditure level of \$99.0 million in constant 1988 dollars over the 20 year period.

Scenario 4: This assumes that sufficient funding is available to eliminate all level of service deficiencies, the same as in Scenario 3, but completed by 2003, a 15 year time frame. Given the total study network improvement costs of \$1,979.2 million, this would entail an average annual expenditure level of \$131.9 million in constant 1988 dollars.

Table 6.5 presents a summary of the gross economic impacts of the highway construction programs associated with each funding level scenario. This indicates that the most extensive and concentrated economic impacts arise from Scenario 4. An average 904 person-years of direct construction employment and 831 person-years of indirect employment are created or retained yearly by the level of construction activity generated by Scenario 4.

Table 6.5

GROSS ECONOMIC IMPACTS OF FUNDING LEVEL
SCENARIO HIGHWAY CONSTRUCTION PROGRAMS

Funding Scenario	Expenditures (\$1988 x 000)			Employment (Person-Years)		
	Direct	Indirect	Total	Direct	Indirect	Total
AVERAGE ANNUAL IMPACT:						
1	19,793	14,682	34,475	107	99	206
2	28,791	21,357	50,148	155	142	297
3	98,958	73,406	172,364	678	623	1,301
4	131,944	97,874	229,818	904	831	1,735
TOTAL PROGRAM IMPACT:						
1	395,860	293,643	689,503	2,146	1,974	4,120
2	575,820	427,135	1,002,955	3,092	2,844	5,936
3	1,979,160	1,468,113	3,447,273	13,556	12,468	26,024
4	1,979,160	1,468,113	3,447,273	13,556	12,468	26,024

6.3 Funding Scenario Implementation Plans

Given the expenditure levels associated with each funding scenario and based on the priority evaluation model rankings of the route segments from Chapter 5.0, implementation plans have been developed for the study highway network. The model rankings of the route segments have provided a guideline for implementation in the plans, but some minor variations in scheduling have been undertaken to avoid construction and traffic anomalies. For instance, a lower rated highway segment connecting two other segments may be scheduled ahead of a higher rated segment to avoid moving from a four lane divided highway to a two lane and back to a four lane in successive highway segments.

It should be noted that Route Segment 2-02: St. Jacques to Hebert Blvd. upgrading to four lane divided status, and 7-05: Grand Bay By-Pass to Saint John are presently in progress, and therefore are not included in the implementation plans. Route Segment 1-07: Lorneville to Gondola Point is presently a four lane divided highway but will require upgrading to six lanes during the plan periods. Because of the possible route alignment for the Trans Canada Highway from Fredericton to Jemseg, Route Segment 7-01: Fredericton to Oromocto has been incorporated with 2-18: Fredericton to Jemseg.

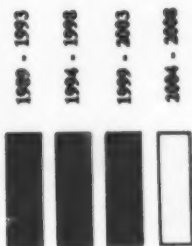
Figures 6.1 to 6.4 illustrate the implementation plans for the four respective funding scenarios. Figure 6.1 presents the 20 year implementation plan for Scenario 1 divided into 5 year program increments. Only six route segments, with most of a seventh, are completed under the Scenario 1 funding level. These projects are all along the Trans Canada Highway Route 2. Funding over the first 5 years is insufficient to complete the highest ranked route segment from Petitcodiac to Moncton.

Figure 6.2 illustrates the 20 year implementation plan for Scenario 2 divided into 5 year program increments. Ten route segments with most of an eleventh are completed under the Scenario 2 funding level. These projects are mostly along the Trans Canada Highway with one route segment completed on Route 1 from Gondola Point to Hampton extending from the present four lane divided highway through Saint John. Funding for this scenario only allows the route segment from Petitcodiac to Moncton and less than half of the segment from Longs Creek to Fredericton to be completed during the first five years.

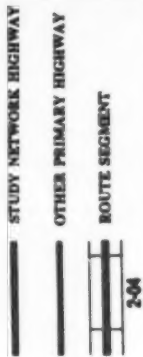
Figure 6.3 presents the 20 year implementation plan for Scenario 3 divided into 5 year program increments. This plan would see Sussex to Moncton, Longs Creek to Fredericton, Edmundston to Saint Leonard, Jackville to the Nova Scotia border and most of Gondola Point to Hampton completed in the first five years. Most of the Trans Canada Highway Route 2 would be upgraded to four lane divided status in the first 15 years, except for just over two route segments in the Perth-Andover area. All of Route 1 would be four laned within 15 years.

LEGEND:

IMPLEMENTATION PHASES



NOTE: AVERAGE = \$19.8 M. per annum
(\$ 1988)



DRAWING TITLE:

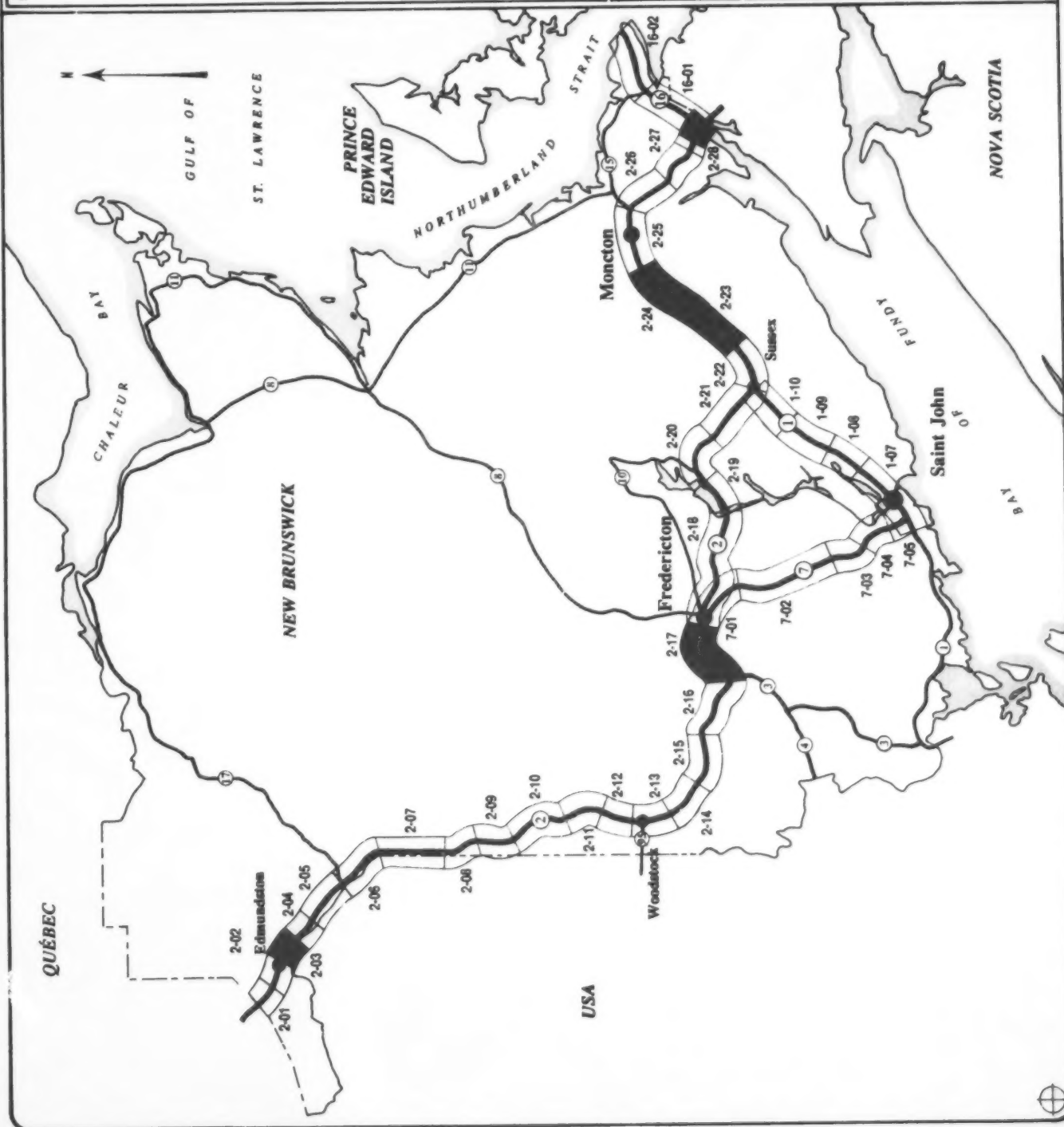
**FIGURE 6.1
SCENARIO #1
PROVINCIAL FUNDING LEVEL
PLUS HIGHWAY TRUST FUND
ALLOCATION**

PROJECT TITLE:

**A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK**

DRAWN BY: JTCB
SCALE: Not to Scale
DATE: 8/89
PROJECT #: 537-11

**FGA FIANDER-GOOD
ASSOCIATES LTD.**

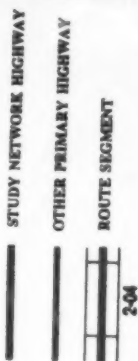


LEGEND:

IMPLEMENTATION PHASES



NOTE: AVERAGE = \$28.8 M. per annum
(\$ 1998)



DRAWING TITLE:

FIGURE 6.2

SCENARIO #2
PROVINCIAL AND FEDERAL /
PROVINCIAL FUNDING LEVELS
PLUS HIGHWAY TRUST FUND
ALLOCATION

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

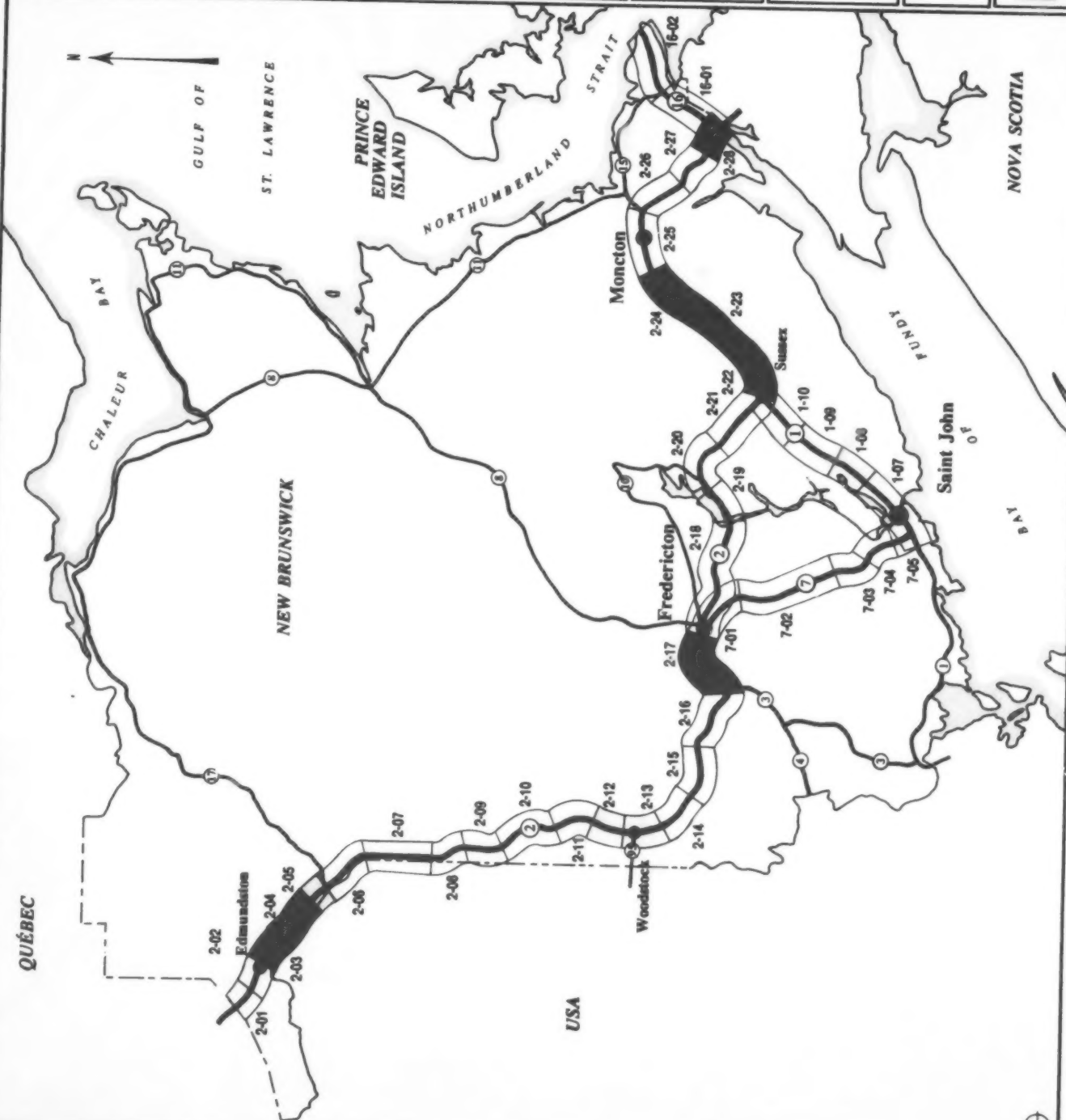
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DATE: 8/89

SCALE: Not to Scale

PROJECT #: 37-11

FGA FIANDER - GOOD
ASSOCIATES LTD.

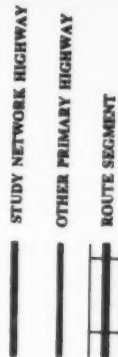


LEGEND:

IMPLEMENTATION PHASES



NOTE: AVERAGE = \$98.96 M. per annum (\$ 1988)



2-04

DRAWING TITLE:

FIGURE 6.3
SCENARIO 43
FUNDING LEVEL TO
COMPLETE PROPOSED NETWORK
IMPROVEMENTS IN 20 YEARS

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

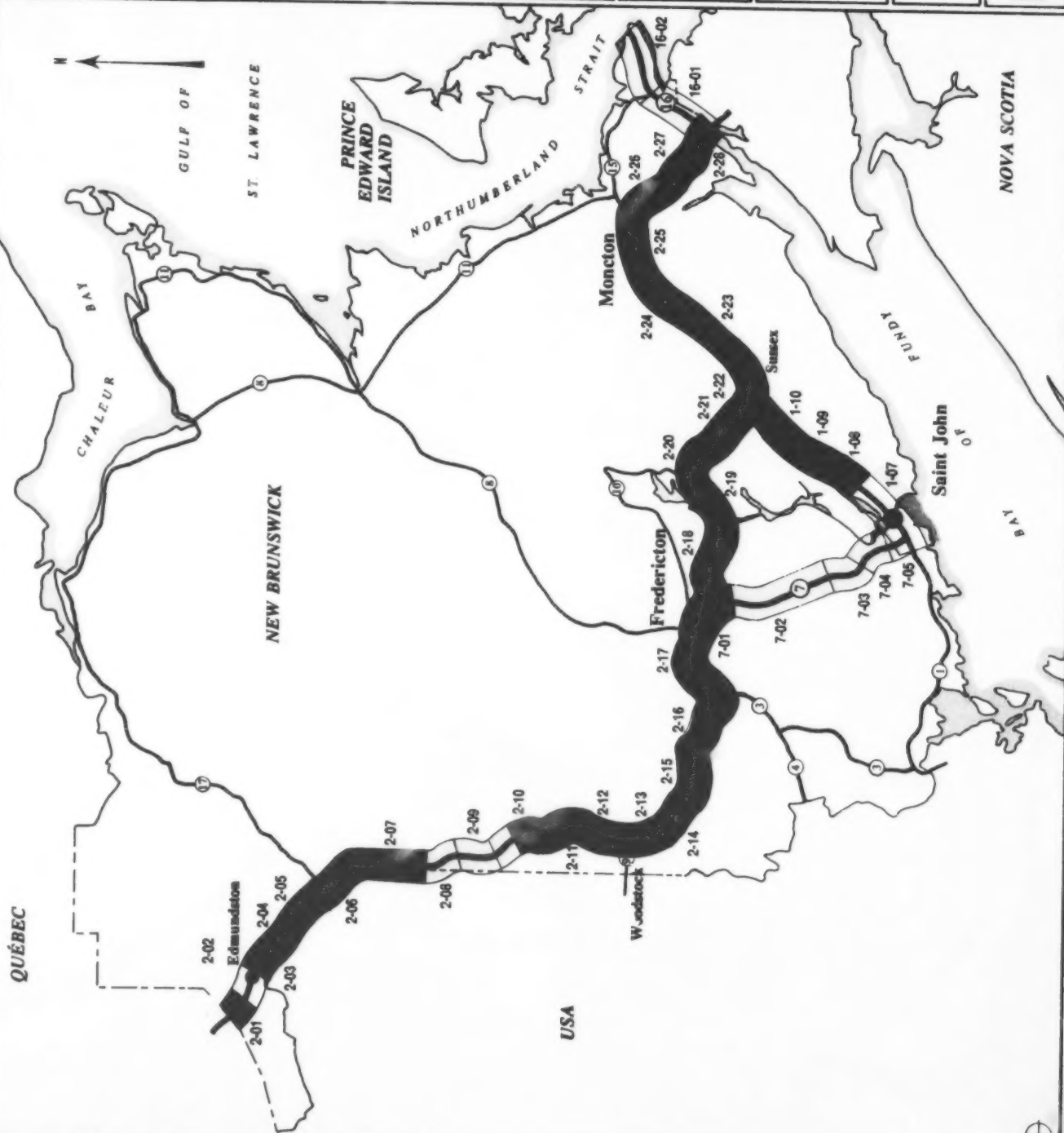
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DATE: 03/89

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PROJECT #: 317-11

FGA FIANDER - GOOD
ASSOCIATES LTD.

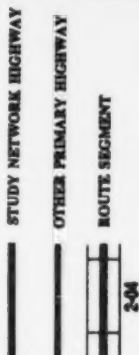


LEGEND:

IMPLEMENTATION PHASES



NOTE: AVERAGE = \$131.9 M. per annum (\$ 1988)



DRAWING TITLE:

FIGURE 6.4

SCENARIO 64
FUNDING LEVEL TO
COMPLETE PROPOSED NETWORK
IMPROVEMENTS IN 15 YEARS

PROJECT TITLE:

A
HIGHWAY IMPROVEMENT PLAN
FOR THE
TRANS CANADA HIGHWAY
THROUGH NEW BRUNSWICK

DRAWN BY: JTCB

DATE: 6/89

SCALE: Not to Scale

PROJECT #: 537-J1

FGA FLANDER - GOOD
ASSOCIATES LTD.

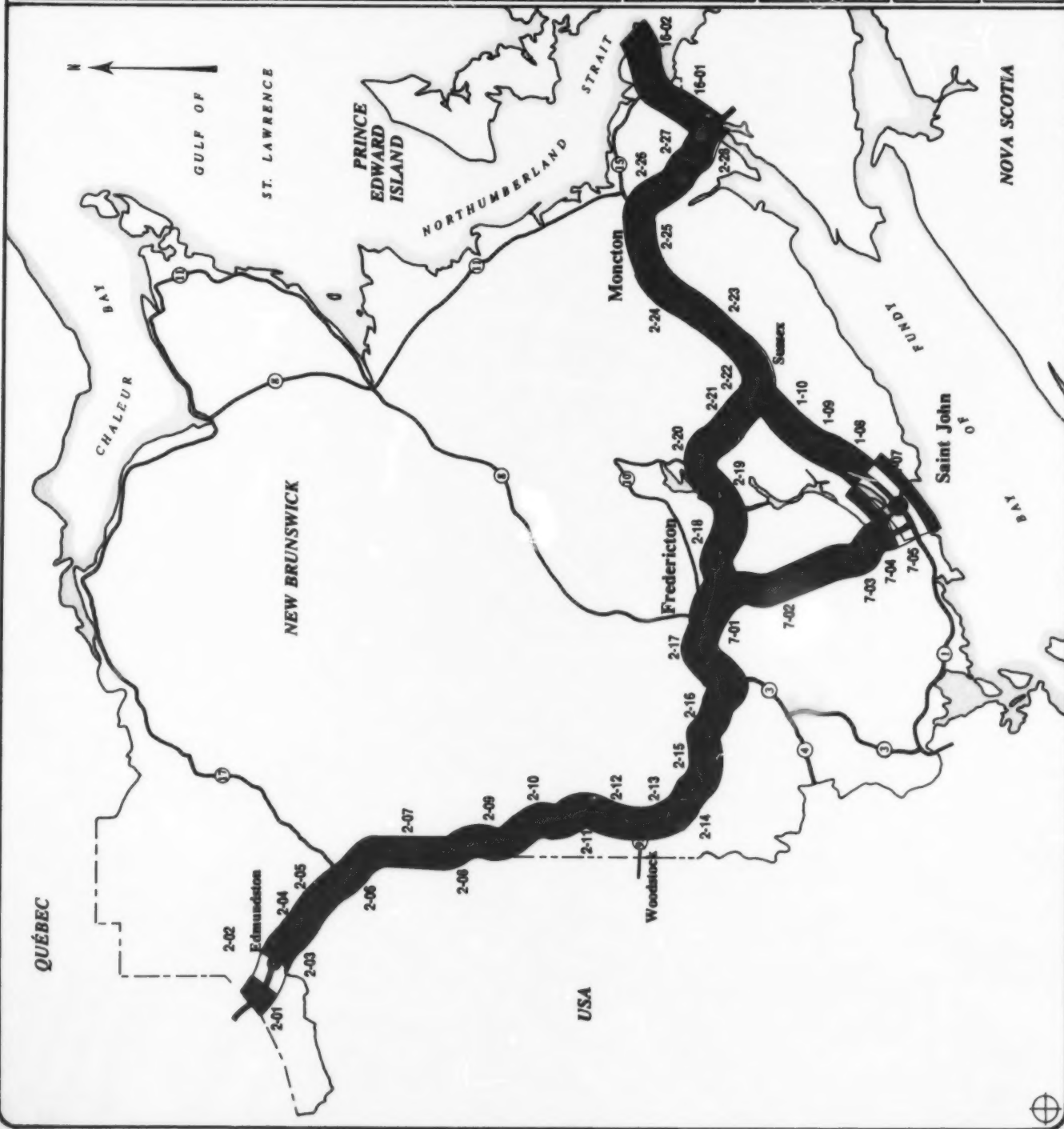


Figure 6.4 illustrates the 15 year implementation plan for Scenario 4 divided into 5 year program increments. All of Route 1 would be four laned within the first 10 years of this program. All but the route segments from Grand Falls to Hartland on Trans Canada Highway Route 2 would also be completed within 10 years. Edmundston to beyond St. Leonard, Hartland to Meductic, Longs Creek to Fredericton, Sussex to Moncton and Sackville to Nova Scotia would be completed on the Trans Canada Highway in the first five years. Gondola Point to Hampton on Route 1 would also be completed in the first 5 year period under Scenario 4.